



AAACE® International Recommended Practice No. RM-32

REQUIRED SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT

TCM Framework: 7.6 – Risk Management

Rev. April 6, 2021

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Any terms found in AAACE Recommended Practice 10S-90, *Cost Engineering Terminology*, supersede terms defined in other AAACE work products, including but not limited to, other recommended practices, the *Total Cost Management Framework*, and *Skills & Knowledge of Cost Engineering*.

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TABLE OF CONTENTS

Table of Contents	1
1. Introduction	2
1.1. Purpose	2
1.2. Who is a PRMP?	2
1.3. What is Risk Management?	2
2. Recommended Practice	3
2.1. Basis of Project Risk Management Required Skills and Knowledge	3
2.1.1. Skills and Knowledge Priority Designations	3
2.2. Outline of Project Risk Management Skills and Knowledge	4
References	4
Contributors	6
Appendix – Outline of the Skills and Knowledge of Project Risk Management.....	6

Special Note on the Draft RP prepared for the PRMP Beta Exam Use:

This draft RP may include some duplication of topics which may be different headings. We request that the beta exam test takers provide feedback on any issue that you would like to bring to AACE’s attention. Comments received from you will be taken into consideration for the final RP.

1. INTRODUCTION

This recommended practice (RP) is intended to serve as a guideline, not a standard. As a recommended practice of AACE International, the intent of the guideline is to define the required skills and knowledge to perform project risk management (PRM). It serves as the foundation of the skills and knowledge of an AACE certified Project Risk Management Professional (PRMP) and provides an outline for its study guide. PRM requires knowledge ranging from analytical (e.g., statistics and modeling) to socio/psychological (e.g., risk elicitation and communication) to management (e.g., risk response planning and management). PRM is practiced within the context of all the processes and practices of total cost management (TCM). All TCM practices have elements of uncertainty and the need to make some decisions, and interfaces with all the associated disciplines working in a TCM process.

1.1. Purpose

This RP highlights the necessary skills and knowledge of a PRM practitioner from a high-level viewpoint. It identifies competencies for a risk management practitioner as it relates to their broad experience in performing technical analyses such as schedule risk analysis, cost risk analysis (or integrated cost-schedule risk analysis) to qualitative risk management that deal with the development of a risk management plan (RMP), risk identification through risk workshops or interviews, qualitative risk analysis, development of risk response planning, and risk monitoring and control during the life of the project. Detailed skills, knowledge, and methodology are excluded from this recommended practice. These skills and knowledge are applicable to the project risk management profession across any industry, portfolio, program, or project in which TCM applies. It is aligned with RP 11R-88, *Required Skills and Knowledge of Cost Engineering* and the *Total Cost Management Framework*.

1.2. Who is a PRMP?

A PRMP is a skilled and knowledgeable practitioner whose role is to establish an effective risk management plan and implement that plan in accordance with the project/program/portfolio's objectives. It is the PRMP's responsibility to clearly communicate in verbal and written forms, both internally and externally. Certification as a PRMP recognizes certificate holders who have demonstrated their expertise in project risk management, which includes the following:

- Risk management supporting skills and knowledge.
- Risk management skills and knowledge.
- Other functional skills and knowledge.

1.3. What is Risk Management?

The *TCM Framework* (Section 7.6) defines risk management as a systematic and iterative process comprised of four steps:

1. Plan - establish risk management objectives.
2. Assess - identify and analyze risk.
3. Treat - plan and implement risk responses.
4. Control - monitor, communicate and enhance risk management effectiveness.

The goal of risk management is to increase the probability that a planned asset, project or portfolio achieves its objectives. In TCM, potential deviations from plans are all considered potentially adverse to overall performance. In this sense, perceived opportunities may also pose a threat. However, if properly managed, the project or asset

April 6, 2021

management team may be able to capitalize on opportune uncertainties. As discussed in TCM, a key challenge in planning is bringing an awareness of risk and probability concepts to decisions whether they are implemented or not.

2. RECOMMENDED PRACTICE

2.1. Basis of Project Risk Management Required Skills and Knowledge

This RP outlines those skills and knowledge topics required for a professional to be able to effectively perform the processes and steps outlined in the *Total Cost Management Framework* chapter on *Risk Management* (TCM 7.6). As these processes are highly integrated with and sometimes practiced within the other TCM processes, elements of those are also included.

The required skills and knowledge of cost engineering are documented in RP 11R-88, *Skills and Knowledge of Cost Engineering*, which is a structured outline including performance statements for most topics (e.g., “Be able to define...”). The scope or topic headings for this RP and 11R-88 largely overlap; the difference is primarily in emphasis or the level of required skills. For example, the cost engineer should have application knowledge of schedule model development (e.g., given a schedule network with durations, perform CPM forward and backward pass calculations to determine float) while the project risk management practitioner must have comprehension (e.g., understand the concept of logic networks and CPM). On the other hand, the PRM practitioner must have application knowledge of a range of probability distribution functions (PDF) while a cost engineer need only have comprehension.

In summary, this RP looks at the process and steps of TCM 7.6 and summarizes those in a topic outline focused solely on PRM, adding the missing priority designations. In some cases, additional detail is added (e.g., typical PDFs) and/or performance statements are modified to address specific PRM requirements.

2.1.1. Skills and Knowledge Priority Designations

When assessing the level or degree of skills and knowledge, the following are some generic performance statements that apply:

- Knowledge: Recalls facts and information (e.g., define, list, state, identify, label, name)
- Comprehension: Demonstrates understanding of facts and terminology (e.g., describe, explain, predict, interpret, summarize)
- Application: Can use information in concrete situations (e.g., apply, solve, show, make use of, modify)
- Analysis: Can break material down into its parts, identifying both the parts and their relationships to each other (e.g., differentiate, compare/contrast, distinguish)
- Synthesis: Can put the parts together to produce a unique entity, generate a plan, or derive new relationships (e.g., design, construct, develop, formulate)
- Evaluation: Can use evidence and criteria to judge the value of a thing for a given purpose (e.g., appraise, evaluate, justify, judge, recommend)

This RP only has two designations: primary and secondary (P or S). A primary (P) skills and knowledge topic will be one that the PRM practitioner should be able to understand and perform at any of the levels in the list above. A secondary (S) skills and knowledge topic will be one where the expected understanding is only knowledge and comprehension.

2.2. Outline of Project Risk Management Skills and Knowledge

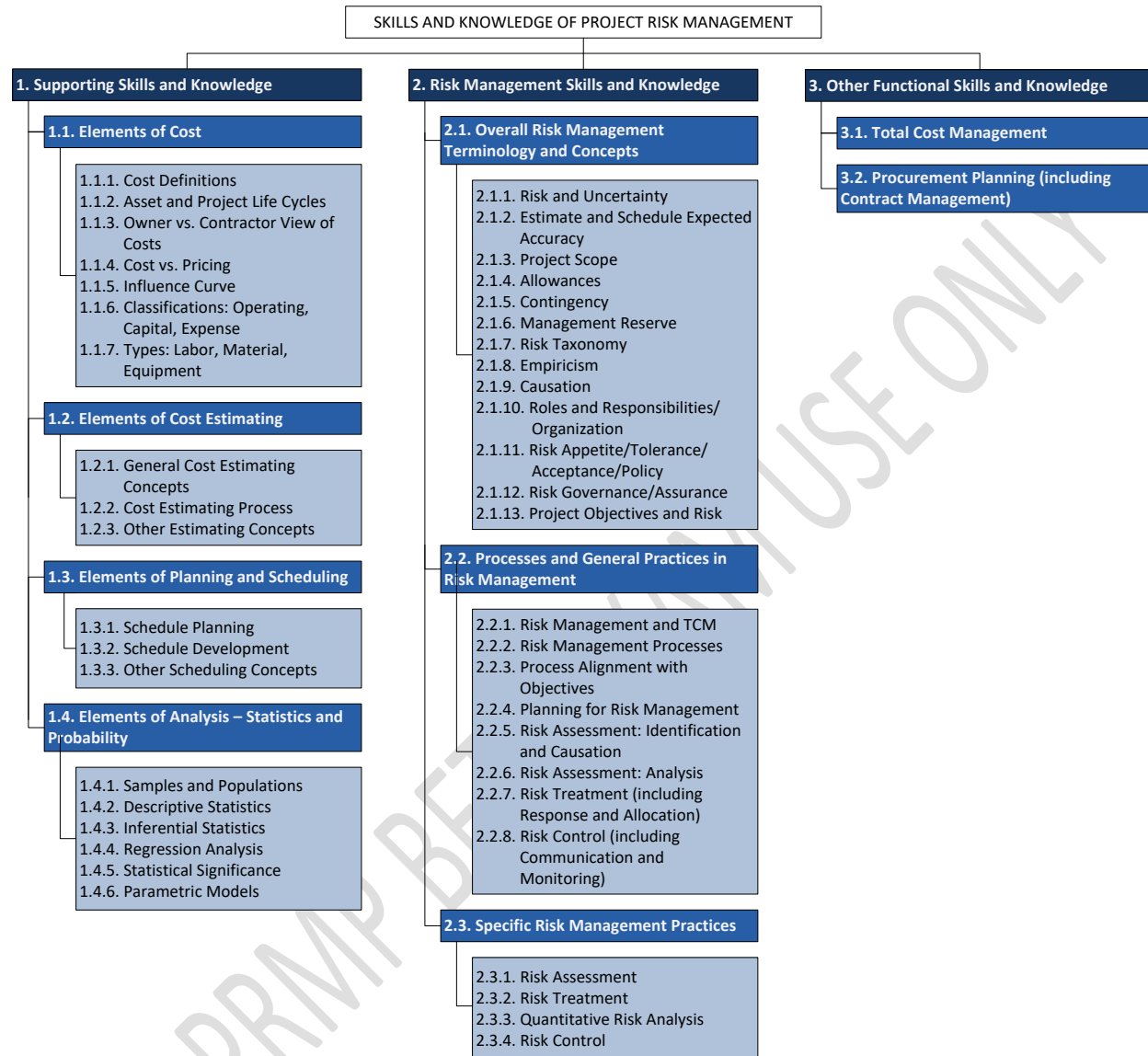


Figure 1. High Level Outline of Skills and Knowledge of Project Risk Management

A detailed table that correlates the project risk management topics and performance statements to the skills and knowledge areas described in 11R-88, *Required Skills and Knowledge of Cost Engineering* is included as an appendix. This table includes additional skills and knowledge required specifically for a PRM professional.

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April 6, 2021

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April 6, 2021

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APPENDIX – OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT

In the following detailed outline, a “P” in the leftmost column indicates key concepts that form the major emphasis for the AACE International Project Risk Management Professional (PRMP) certification examination; while an “S” identifies concepts with less emphasis in the examination (although not necessarily of less importance).

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P/S	1. Supporting Skills and Knowledge
	1.1. Elements of Cost
	1.1.1. Cost Definitions
S	Resources
S	Time
S	Cost
	1.1.2. Asset and Project Lifecycles

April 6, 2021

 OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Lifecycle: be able to describe this term and differentiate the life cycle of an asset and a project.
	1.1.3. Owner vs. Contractor View of Costs
S	Responsibility: Be able to describe and differentiate the cost perspectives of an owner and a contractor/supplier.
	1.1.4. Cost vs. Pricing
	Pricing
S	Be able to explain the difference between cost and pricing. Price Strategy:
S	Be able to describe how business strategy and market forces may affect pricing.
S	Be able to describe from an owner or buyer perspective concerns about pricing (e.g., risks, competitiveness, cash flow).
S	Be able to describe how profit affects pricing
S	Be able to describe how profit may be determined how the different types of contracts may influence the amount
	1.1.5. Influence Curve
S	Influence: Be able to explain the concept of the influence curve.
	1.1.6. Classifications: Operating, Capital, Expense
	Cost classifications:
	Explain the general differences between the ways costs are classified for various cost management purposes.
S	Capital vs. Operating
S	Capital vs. Expense
S	Direct vs. Indirect
S	Fixed vs. Variable
	1.1.7. Types: Material, Labor, Subcontract, and other Cost Issues
	Material:
	Material types: Be able to describe the types and their cost drivers
S	Raw
S	Bulk
S	Fabricated
S	Engineered or designed
S	Consumables
	Material pricing: Be able to describe market pricing, and their influence on material costs
S	Sole sourced vs. negotiated vs competitively bid
S	Quantity discounts
	Material management: Be able to describe material management issues, and their influence on material costs
S	Delivery schedule
S	Shipping and freight
S	Storage and inventory
S	Losses (e.g., waste, theft, damage)
S	Spare parts (e.g., commissioning and start-up, capital, operating)
	Labor:
	Labor wage rate or salary:
S	Be able to describe the differences in compensation for salaried and wage employees:
S	Overtime premiums
S	Other wage premiums

April 6, 2021

 OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Impact of work-week schedule and work shifts
S	Compensation for travel time, show-up pay, and other issues
	Labor benefits and burdens:
	Be able to describe various benefits and burdens, including the differences between mandated and fringe:
S	Retirement (e.g., social security)
S	Unemployment insurance
S	Worker's compensation
S	Time of with pay (e.g., vacation, sick)
S	Other benefits and/or burdens that may be location-specific
	Overheads and Profits that may be accounted for in labor costs:
S	Be able to describe various overhead and other costs that may be accounted for in labor wage costs:
P	Indirect labor (e.g., home office overhead, administrative overhead)
S	Construction support costs (e.g., small tools, consumables)
S	Profit and/or fee
S	Union vs/ non-union: Be able to explain the differences and the impact on labor costs
	Subcontract:
	Be able to explain the cost impacts of various subcontract cost issues:
S	Reimbursable vs. non-reimbursable
S	Overhead, indirect cost and profit (including contract administration and legal costs)
	Other Cost Issues: Be able to explain and evaluate the cost impact of the following cost issues.
S	License fees and royalties
S	Bonds (e.g., bid, payment, performance)
S	Performance guarantees, warranties, retainage
S	Inflation
S	Escalation
S	Currency and exchange rates
	1.2. Elements of Cost Estimating
	1.2.1. General Cost Estimating Concepts
S	Be familiar with cost estimating terminology
P	Be able to describe cost estimate classification in general, and how the various estimate classes related to the level of supporting project definition.
S	Be able to describe the typical estimating methodologies associated with the various estimate classes.
S	Be able to describe factors that may affect estimate variability.
S	Be able to describe cost estimates as predictions of probable costs for a given scope, location, and time frame.
P	Be able to describe cost estimate contingency and explain both inclusions and exclusions
P	Be able to describe various methods of cost estimate contingency assessment
	1.2.2. Cost Estimating Process
	Estimate Planning
P	Be able to describe the importance of establishing the purpose of the estimate (what decision gate is the estimate supporting) in relation to competitiveness and risk tolerance
P	Understand the levels of scope definition required for various estimate classes in relation to potential risks (systemic and project-specific)

April 6, 2021

 OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Be able to describe the various methods of structuring the estimate (e.g., Work Breakdown Structure, Organization Breakdown Structure, Cost Breakdown Structure)
S	Be able to describe the importance of appropriate coding structures and their benefits to estimating and project controls
Estimate Quantification	
S	Understand the various estimating quantification and estimating methodologies in relation to estimate class and level of supporting project definition
P	Be able to describe potential estimating uncertainty in relation to quantification methods and the level of supporting project definition.
Estimate Costing and Pricing	
S	Be able to describe the process of costing the estimate as the translation of quantified scope information into resource requirements and un-adjusted estimate costs
S	Be able to describe the process of estimate conditioning as the process of adjusting the estimated costs for project specific conditions and requirements
S	Be able to describe the process of pricing the estimate as adjusting the estimated costs for market conditions and business interests (including adjustments for overhead and profit as required by the estimate stakeholders).
Estimate Budgeting	
S	Be able to describe budgeting as the process of translating the estimate structure into costs accounts against which cost performance can be measured and controlled.
S	Be able to describe the budget as the baseline for cost control performance assessment.
Estimate Review, Validation and Documentation	
P	Be able to describe the importance of effective estimate review and validation to estimate quality; and to the identification and assessment of potential uncertainty and risk.
P	Be able to describe the importance of historical, empirical information and benchmarking to support estimate validation.
P	Be able to describe the typical content of estimate documentation, including the basis of estimate.
Estimate Risk Funds	
P	Be able to describe estimate contingency and explain both inclusions and exclusions.
P	Be able to describe various methods of estimate contingency assessment.
P	Be able to describe the concept of estimate accuracy in statistical terms (e.g., confidence intervals).
P	Be able to describe and explain management reserve, and the difference between contingency and management reserve.
P	Be able to describe escalation and the various methods of escalation estimating.
1.2.3. Other Estimating Concepts	
S	Be able to compare and contrast estimating versus bidding, and consideration of a contractor/supplier bid as an input to an owner estimate
S	Be able to describe life-cycle cost estimating and be able to compare and contrast to life-cycle cost estimating in terms of risk evaluation.
S	Be able to describe the time-phasing of an estimate or budget as a cash-flow.
1.3. Elements of Planning and Scheduling	
1.3.1. Schedule Planning: Be able to describe and explain the following concepts	
P	Schedule activities
S	Activity logic and diagramming methods (including understanding of lags and constraints)
S	Activity duration

April 6, 2021

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

	Critical Path:
P	Be able to define and identify the critical path(s) in a project schedule
P	Be able to describe the concepts of near critical path, sensitivity, cruciality, and criticality with respect to schedule risk analysis
	Float:
P	Be able to describe the concepts of free float and total float with respect to schedule risk analysis
P	Be able to describe the concepts and differentiate between float and schedule contingency
	Schedule Models:
S	Using the PDM method, be able to describe and explain the calculation of early start/finish dates, late start/finish dates, free float, total float, and minimum project completion duration given a logic diagram and activity durations.
	Bar charts
S	Be able to explain the differences between logic diagrams and bar charts.
S	Be able to prepare a bar chart given network activity durations, early and late start/finish dates, and total float.
S	Historical Data: Be able to describe the importance of historical, empirical data to scheduling planning and development.
	1.3.2. Schedule Development: Be able to differentiate between schedule planning and development, and describe the following concepts:
S	Schedule milestones
S	Resource loading
S	Resource leveling
S	Schedule optimization
S	Schedule optimization
	1.3.3. Other Scheduling Concepts:
	Schedule strategy:
P	Be able to describe the characteristics and risks of a fast-track schedule
P	Be able to describe the importance of the cost and schedule tradeoff in schedule planning
P	Be able to describe the importance of schedule logic and model quality to CPM-based schedule risk analysis
P	Be able to describe the concepts of schedule acceleration/crashing with respects to risk, and as a potential approach for risk treatment and response
	Schedule contingency:
P	Be able to describe schedule contingency and explain both inclusions and exclusions
P	Be able to describe various methods of schedule contingency assessment
P	Be able to describe the concept of risk-driven delay and its implications for schedule planning and development
P	Be able to describe the concept of schedule accuracy in statistical terms (e.g., confidence intervals)
	1.4. Elements of Analysis - Statistics and Probability
	1.4.1. Samples and Populations:
P	Be able to describe the relationship of the mean of a sample to the mean of a population, and the general effect of sample randomness, bias and size on the reliability of the sample statistics.
P	Central Limit Theorem: be able to define and explain this concept
P	Pareto Principle: be able to define and explain this concept
	1.4.2. Descriptive Statistics

April 6, 2021

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P	Basic Statistics: given a set of data, be able to determine the arithmetic mean, median, mode, standard deviation and variance.
P	Normal Distribution: be able to provide the percent of observations within one and two standard deviations of the mean for a normally distributed variable.
	Non-Normal Distributions: be able to describe the following concepts:
P	Skewness (symmetry)
P	Kurtosis (central tendency relative to normal).
	Probability Distribution Functions (PDFs): be able to describe the following concepts:
P	Bounded vs. Unbounded PDFs
P	Discrete vs. Continuous PDFs
P	Confidence levels and intervals
	Histograms, Cumulative Frequency:
P	Given a tabular distribution for a variable, be able to draw a histogram and cumulative frequency curve
P	Using a histogram or cumulative frequency curve, be able to determining the percent probability for a variable being less than or more than a given value
	1.4.3. Inferential Statistics
	Probability: Given a Probability Distribution Function curve and axis data, be able to determine:
P	The probability of a variable being between any two values
P	The probability of a variable being higher for lower than a given value
P	Given a confidence interval or range, determine the corresponding low and high values
	Probability Distribution Functions: Be able to describe key characteristics of the following PDF types, and describe their strengths, weaknesses and applicability for use in risk analysis models
P	Discrete
P	Uniform
P	Triangular
P	Double Triangular
P	Trigen
P	Normal
P	Lognormal
P	Pert or Betapert
P	Binomial
	1.4.4. Regression Analysis: be able to describe the concept of the methodology as well as diagnostic statistics (e.g., R-squared, root mean square error, t value, f value)
S	Be able to describe the concept and methodology of regression analysis
S	Be able to explain regression analysis diagnostic statistics (e.g., R-squared, root mean square error, t value, f value)
	1.4.5. Statistical Significance:
S	Be able to describe the purpose and use of chi-squared and t-tests
S	Be able to interpret the t-statistic for comparing two sets of normally distributed data.
S	Be able to interpret the chi-squared statistic for comparing two sets of data that may not be normally distributed.
	1.4.6. Parametric Models
P	Be able to describe how a parametric model may incorporate probabilistic properties
	1.5. Enabling Knowledge
	1.5.1. Ethics

April 6, 2021

 OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Be able to explain the need to judge the means and the ends of a practice or process against personal and societal values and rules of conduct.
P	Be familiar with AACE International's ethics policy (Canons of Ethics).
P	Be able to describe common ethical issues as potential risks and their impacts.
1.5.2. Organization/Leadership/Teams	
P	Organizational Structures: Understand how various organizational structures may impact project teams and influence risk
S	Leadership: Be able to explain why it is important to obtain team commitment and clearly communicate the purpose of a task or project, and how this might be done.
S	Teams: Understand how project team roles and responsibilities may affect project performance and influence risk
S	Organizations in TCM: Be able to describe the typical roles of capital investment management, operations management, and project management in Total Cost Management.
1.5.3. Project Cultures/Biases	
P	Be able to describe issues relating to project team culture and biases that may have an impact on project cost and schedule, and that may impact risk assessment (e.g., identification, elicitation, qualitative/quantitative risk analysis).
P	Be able to describe and explain the concept of risk aversion.
	Be cognizant of and prepared to deal with biases and issues such as:
P	Confirmation bias: Focusing on reinforcing information, but potentially ignoring non confirming information
P	Optimism bias: A trust that things will work out positively, while ignoring potential negative events or impacts
P	Anchoring: A trust in early or initial information that may not be warranted.
P	Group Think: A tendency to be influenced by peer pressure or vocal members of the project team
P	Illusion of Control: Underestimating future uncertainty based on incomplete information or the overestimating the ability to control future events.
S	Other biases and issues that may affect an effective risk assessment.
1.5.4. Performance/Productivity/Human Factors:	
P	Be able to describe the concept of productivity (and its difference from the term production). Be able to describe how performance, productivity and human factors may contribute to uncertainty:
P	Individual worker skills
P	Crew balance of skills
P	Immediate supervision competence
P	Overall supervision competence
S	Worker and supervision attitudes
P	Work force sociological, cultural and demographic characteristics
P	Absenteeism and turnover
P	Workweek schedule, overtime, and work shift schedule
P	Level of technology used
S	Learning curve
P	Work area environment
P	Weather
P	Geographic location
P	Proximity to other work and contractors
S	Job layout

April 6, 2021

 OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Work rules
P	Safety practices
P	Materials and tools availability
P	Wages, salaries and benefits
S	Be able to describe assess the cost/schedule impacts associated with efforts to improve performance
1.5.5. Quality/Cost of Quality	
S	Quality: Be able to describe this as conformance to requirements (which are based on customer needs).
S	Quality Planning: Be able to describe this as an integrated way of planning directed towards satisfying customer needs.
S	Quality Management: Be able to describe this as a process for managing quality understanding that TCM is a quality management process focused on continuous cost performance improvement.
S	Quality Assurance: Be able to describe this as actions that provide confidence that the requirements will be fulfilled.
S	Quality Measurement: be able to cost as the best single quality measurement because so many measures can be expressed in terms of cost.
S	Quality Control: Be able to describe this as actions focused on fulfilling requirements
S	Quality Policy: Be able to explain that this as an imposed requirement that is guided by accepted quality management principles
S	Quality Standards: Be familiar with quality standards such as:
S	ISO 9000 standard quality management series
S	ISO 10006 quality in project management
S	ISO 31000 quality in risk management
S	Continuous Improvement: Be able to describe this as a common goal of quality management processes (the traditional result of the PDCA process).
P	Plan-Do-Check-Assess/Act (PDCA): be able to describe this as a quality-driven basis model for TCM and many other management processes.
S	Risk Management Quality Control Programs: Be able to describe the expectations, requirements, and practices of risk management quality processes.
1.5.6. Environment, Health, Safety, Security, Sustainability	
S	Be able to describe TCM as a quality-driven process that focuses on establishing EHSSS requirements and managing to them.
S	Be able to explain why compliance with minimum EHSSS standards and regulations should be expected and planned for.
S	Be familiar with environmental standards such as:
S	ISO 14000 environmental management
S	Be able to explain why enterprises should focus on sustainability and not use resources in a manner that compromises future generations
S	Be able to assess and address risk issues related to non-conformance with EHSSS requirements
1.5.7. Legal	
S	Be able to describe the general concepts of legal requirements (e.g., rules, regulations, constraints) related to projects
S	Be able to assess and address risk issues related to non-conformance with legal requirements
1.5.8. Insurance/Bonding	
S	Be able to describe the various types of insurance that may be required in projects and contracts
S	Be able to describe the various types of bonds that may be required in projects and contracts

April 6, 2021

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Be able to describe the general concept of insurance in respect to risk treatment
	1.5.9. Contracting
P	Be able to describe the various types of contracts that may be used in projects
P	Be able to describe the advantages and disadvantages of various types of contracts in regards to risk allocation and risk treatment
S	Be able to describe the general contents and purposes of bidding and contract documents in regards to risk management
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes, and claims.
	1.5.10. Market Conditions and Economics
P	Be able to describe the general concepts of market conditions and economics in regards to potential risks impacting revenues and costs.
	1.5.11. Stakeholder Management
P	Be able to describe and identify various project stakeholders.
P	Be able to describe the general concepts of stakeholder management in regards to planning and implementing risk management
P	2. Project Risk Management Skills and Knowledge
P	2.1. Overall Project Risk Management Terminology/Concepts
P	2.1.1 Risk and Uncertainty
P	Be able to describe risk and uncertainty in terms of opportunities and threats
P	2.1.2 Estimate and Schedule Expected Accuracy
P	Estimate and schedule variability
P	Be able to describe the elements, conditions, activities, and factors that may affect project cost estimate and schedule variability
P	Be able to describe a project cost estimate or schedule as a prediction (or probabilistic assessment) associated with a ranges of values
P	Be able to describe the importance of communicating the probabilistic nature of project cost estimates and schedules to the project team and project stakeholders
P	Be able to describe project characteristics that are likely to affect the accuracy of project cost estimates and schedules, and their relationship to estimate and schedule classification
P	Be able to describe the concept of expected accuracy for project cost estimates and schedules in statistical terms (e.g., confidence intervals)
P	2.1.3 Project Scope
P	Be able to describe project scope as the quantification of all resources (e.g., material, labor) required to meet project requirements, and includes definition of all other information (e.g., location, strategies) to implement the project.
P	Be able to describe decomposition as the breakdown of project elements and activities into manageable (controllable) groups or components of project scope.
P	Be able to describe various structures of project scope decomposition, such as:
P	Work Breakdown Structures (WBS)
P	Organization Breakdown Structures (OBS)
P	Work Packages
P	Deliverables
P	Project strategies (e.g., contracting, fabrication, execution)

April 6, 2021

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P	Phase Project Development Lifecycle: Be able to describe this concept and its benefits in terms of project scope development, project planning, and risk management.
P	Understand that not all project participants will agree on the meaning of scope, and be able to address the resulting potential impacts to risk planning, assessment, treatment, and control.
P	Understand that the level (or completeness) of project scope definition is a systemic risk driver, and related to estimate and schedule classification
P	2.1.4 Allowances
P	Be able to describe allowances as values to account for known but uncertain (or inadequately defined) project scope; or to account for relatively insignificant elements of cost (or time) for which it is uneconomical to identify in detail.
P	2.1.5. Contingency
P	Be able to describe and explain the following terms:
P	Cost Contingency
P	Schedule Contingency
P	Be able to describe what is and what is not covered by contingency
P	Be able to describe the ways in which contingency should be assessed and quantified
P	Be able to describe the appropriate level of authority to manage project contingencies
P	2.1.6. Management Reserve
P	Be able to describe and explain Management Reserve
P	Be able to describe what is and what is not covered by management reserve
P	Be able to describe the ways in which management reserve should be assessed and quantified
P	Be able to describe the appropriate level of authority to manage management reserve
P	2.1.7. Risk Taxonomy
P	Be able to describe the concepts of risk taxonomy and risk breakdown structure (RBS), and their utilization in risk analysis assessment and communication.
P	Risk Breakdown Structure: Be able to describe the purpose and typical categories of risk breakdown:
P	Risk management process facilitation (e.g., residual, emergent)
P	Risk evaluation methods for contingency determination (e.g., systemic vs. project-specific)
P	Risk driver categorization (e.g., engineering, construction, start-up)
P	Be familiar with ISO 31000 for risk management
P	2.1.8. Empiricism
P	Data, Information, Knowledge: Be able to explain the differences and relationships between these three elements.
P	Databases and database management: Be able to define and explain the following concepts:
P	Project history: the importance of project historical and empirical information to the cost engineering practice.
P	Reference data: The importance of appropriate and trustworthy reference information to specific cost engineering methods and tools.
P	Lessons learned: Consolidated information (typically qualitative in nature) from the experiences of project participants on past projects.
P	Metric: A quantitative measure used for evaluation or comparative purposes.
P	Validation: A quality assurance process, generally quantitative in nature, to assure the appropriateness, reliability, and sometimes competitiveness of data.
P	Basis: In terms of data, the capability to understand the range of the underlying characteristics of the various data points.
P	Normalization: The exercise to adjust data to a common basis (e.g., currency, location, time).

April 6, 2021

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P	Empiricism: Be able to describe the principle of empiricism (relevant experience) and its importance to risk management.
P	2.1.9. Causation
P	Be able to describe and explain the concept of causation, and the difference between causation and correlation
P	Be able to describe and explain the importance of determining cause/effect relationships in risk identification
P	Be able to describe and explain how forensic performance assessment might interact with risk management process (e.g., causation, lessons learned, impact assessment)
P	2.1.10. Roles and Responsibilities/Organization
P	Be able to describe the appropriate level of authority for managing contingency.
P	Roles and Responsibilities: Be able to describe the various roles and responsibilities of project team members supporting risk management.
P	2.1.11. Risk Appetite/Tolerance/Acceptance/Policy
P	Be able to describe the concepts of risk appetite, tolerance, and acceptance; and the formalization of such into an organization's risk policy.
P	Be able to describe risk perception and risk aversion, in relation to psychology, culture and bias.
P	2.1.12. Risk Governance/Assurance
P	Be able to describe the assurance process involved in project risk management.
P	Be able to describe the concept and use of risk maturity models.
P	2.1.13. Project Objectives and Risk
P	Given that risk is "an uncertain event or condition that could affect a project objective," be able to describe how poorly understood project objectives affect risk management effectiveness.
P	Given this definition of a risk, be able to distinguish a risk from an action item requiring attention and a decision that requires resolution.
P	Be able to describe the concept of multiple (and sometimes competing) project objectives, and their consideration and trade-off in risk evaluation.
P	2.1. Processes and General Practices for Project Risk Management
P	2.2.1. Project Risk Management and TCM
P	Be able to describe the processes of risk management in Total Cost Management.
S	Be able to describe the interfaces between project risk management and other project control processes.
S	Be able to describe general project control practices, methods, and activities.
P	2.2.2. Project Risk Management Processes
P	Be able to describe the following project risk management processes at a working level:
P	Risk Management Planning:
P	Be able to describe the concept that project risk management planning begins with establishing risk management objectives.
P	Be able to describe how risk management planning must consider both strategic and tactical requirements for the project, activity, or other alternatives being evaluated.
P	Risk Assessment:
P	Be able to apply the basic practices of risk elicitation and identification (e.g., surveys, brainstorming)
P	Be able to apply the concepts of identifying and assessing risk relationships (e.g., Venn diagrams)
P	Be able to describe the practices of cause/effect and similar analyses to identified risks
P	Be able to apply the concepts of risk registers.

April 6, 2021

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P	Be able to distinguish risks between opportunities and threats; and understand the distinction between risks versus issues and concerns.
P	Risk Analysis:
P	Be able to describe the general principles and practices for risk analysis and contingency determination methods.
P	Be able to describe the concept of quantitative risk analysis, including the use of risk matrices (probability versus impact)
P	Be able to describe the concept of quantitative risk analysis, including Monte Carlo simulation and expected value
P	Be able to apply the recommended practices for project cost risk analysis and estimate cost contingency determination.
P	Be able to apply the recommended practices for project risk analysis and schedule contingency determination, including the preparation of summary schedules in support of schedule risk analysis.
P	Be able to understand and how to apply the recommended practices for integrated project cost and schedule risk analysis.
P	Be able to compare and contrast integrated cost and schedule risk analysis versus serial (separately performed) cost and schedule risk analysis.
P	Be able to describe the concept of conditional branching for application in schedule risk analysis.
P	Be able to describe the concept of merge bias in schedule risk analysis.
S	Be able to apply the recommended practices for estimating escalation and assessing currency risks.
P	Risk Factor Screening:
P	Be able to describe the concepts of qualitative and quantitative screening of risk factors.
P	Be able to apply the concept of tornado diagrams for communicating risk rankings.
P	Risk Treatment (including Response and Allocation)
P	Be able to describe the categories of risk treatments for both threats and opportunities.
P	Be able to apply the practices of contingency planning (contingency response planning).
P	Be able to explain how various contract types allocate risks among the contracting parties.
P	Risk Control (including Communication and Monitoring)
P	Be able to describe how project risk management is integrated with the change management process.
P	Be able to describe how project risk management is integrated with the cost and schedule forecasting process.
P	Be able to explain the process of monitoring and re-assessment of risk factors in accordance with a risk management plan.
S	Be able to describe how earned value and project control performance metrics support risk control.
P	2.3. Specific Risk Management Practices
P	2.3.1. Risk Assessment
P	Objectives and risk: Given that risk is "an uncertain event or condition that could affect a project objective" be able to describe how poorly understood objectives affects decision and risk management effectiveness.
P	Risk factor screening.
P	2.3.1.1. Fault Tree Analysis, Cause/Effect Analysis
P	Be able to describe the practices of fault tree analysis, cause/effect and root cause analysis.

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P	2.3.2. Risk Treatment
P	Risk mitigation or acceptance risk treatment/response planning.
P	Be able to describe the categories of risk treatments for threats and for opportunities.
P	2.3.2.1. Contingency Planning/Contingent Response
P	Contingency action plans.
P	Be able to apply the practices of contingency planning (contingent response planning) and workarounds.
P	2.3.3. Quantitative Risk Analysis
P	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
P	Risk analysis.
P	2.3.3.1. Contingency (Cost and Schedule) and Reserves
P	Risk and uncertainty: Be able to describe these costs:
P	Contingency.
P	Allowance.
P	Reserve.
P	Be able to describe the concept of conditional branching and its potential application in schedule models to support risk analysis.
P	Be able to describe the concept of static (fixed) vs. dynamic (conditional) logic in respect to CPM schedule analysis using Monte-Carlo simulation.
P	Be able to describe the concepts of near critical path, sensitivity, cruciality, and criticality in regards to schedule risk analysis.
P	Be able to differentiate between schedule contingency and float.
P	Be able to describe the concept of merge bias in probabilistic schedule modeling.
P	Be able to describe the importance of considering cost and schedule tradeoff in schedule planning.
P	Be able to describe the importance of schedule model (logic) quality to CPM based schedule risk analysis.
P	Be able to describe the concepts of acceleration and crashing as approaches for risk treatment and response.
P	Schedule contingency:
P	Be able to define the term including what it is supposed to cover.
P	Be able to describe several typical ways that it can be assessed.
P	Be able to describe the concept of delay risk impacts and its implications for schedule planning and development using different modeling methods.
P	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
P	Contingency:
P	Be able to define the term including what cost it is supposed to cover.
P	Be able to describe several typical ways that it can be estimated.
P	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
P	Risk evaluation and contingency determination.
P	Be able to describe how to apply risk analysis to an estimate to support contingency determination.
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to apply the recommended practices for risk analysis and contingency determination.

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

P	Be able to apply the recommended practices for integrated cost and schedule risk analysis and contingency determination.
P	2.3.3.2. Escalation, Inflation, Currency
P	Cost of money: Be able to describe these costs:
P	Escalation.
P	Inflation.
P	Currency exchange rates.
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to apply the recommended practices for estimating escalation and related methods for currency risks.
P	2.3.4. Risk Control
P	Risk control.
P	2.3.4.1. Change Management (Integration with Risk Management)
P	Be able to describe how RM is integrated with the change management process.
P	Be able to describe how earned value metrics might provide risk control information.
P	Contingency, allowances, and reserves (see Risk Management).
P	Be able to describe how the change management and risk management processes are closely aligned during project execution.
P	Manage contingency and reserves:
P	Draw down: Be able to describe methods for managing contingency.
P	Be able to describe ways to assess the need for contingency for work in progress.
P	2.3.4.2. Forecasting (Integration with Risk Management)
P	Be able to describe how RM is integrated with the forecasting process.
P	Be able to describe how risk management may be applied context of work in progress, performance assessment findings, change management, and corrective actions.

S	3. Other Functional Skills and Knowledge
S	3.1. Total Cost Management
S	Total Cost Management (TCM) Process
S	Overall TCM process and terminology.
S	Basic terminology: Be able to explain the following:
S	Plan-do-check-assess (PDCA).
S	Strategic asset.
S	Project.
S	Portfolios and programs.
S	TCM processes: Be able to sketch the TCM, strategic asset management, and project control processes in basic PDCA format and explain the following:
S	The cost management purpose of the overall processes.
S	How the two component subprocesses differ but are related to each other.
S	The benefits of an integrated, systematic cost management approach over the life cycle of assets and projects.
S	Strategic asset management process.
S	Given a representation of the strategic asset management process map (or some portion of it), be able to describe the basic purpose of each step and how it relates to the other steps in the map.
S	Project control process.

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Given a representation of the project control process map (or some portion of it), be able to describe the basic purpose of each step and how it relates to the other steps in the map.
S	Be able to describe the earned value management process as a specific way of applying the project control process (i.e., in what ways is it specialized).
S	3.2. Procurement Planning (Including Contract Management)
S	Overhead and profit: Be able to describe the basic mechanics of charging various overhead and profit cost elements to direct labor costs such as:
S	Indirect labor (home office, administrative and similar costs).
S	Small tools.
S	Profit.
S	Union: Be able to explain the cost differences between union and open shop labor.
S	Subcontract: Be able to explain the cost implications of the following issues:
S	Reimbursable vs. non-reimbursable costs.
S	Overhead and profit (including contract administration and legal costs).
S	License, fees or royalties.
S	Bonds (bid, payment, or performance).
S	Retainage.
S	Performance guarantees.
S	Liquidated damages.
S	Cost of Money: Be able to describe these costs:
S	Escalation.
S	Inflation.
S	Currency exchange rates.
S	Risk and Uncertainty: Be able to describe these costs:
S	Contingency.
S	Allowance.
S	Reserve.
S	Procurement Planning and Contract Management
S	Contract types: Be able to explain the advantage and disadvantages of these types of contracts from the owner and contractor viewpoints:
S	Fixed price (with fixed, incentive, or award fees).
S	Unit price.
S	Cost-plus (with fixed, incentive, or award fees).
S	Time and materials (T&M).
S	Risk allocation: Be able to explain how each contract type above allocates risks between the contracting parties.
S	Contract documents:
S	Be able to describe the general contents and purposes of the following elements of bidding and contract documents:
S	Invitation to bid or request for proposal.
S	Bid form.
S	Agreement.
S	General conditions.
S	Supplementary or special conditions.
S	Technical specifications.
S	Drawings.
S	Addenda.

OUTLINE OF THE SKILLS AND KNOWLEDGE OF PROJECT RISK MANAGEMENT (P = Primary, S = Secondary)

S	Modifications.
S	Bid bond and contract (performance) bond.
S	Performance guarantee.
S	Warranties.
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes and claims (also see Change Management).
S	Be able to describe the various types of insurance that may be required as part of a contract
S	Be able to explain the term "retention" and be able to calculate its effective cost given the terms of the contract and time-value of money.
S	Be able to distinguish between "job (project) overhead" and "general overhead" and provide examples of each.
S	Be able to explain what is meant by a contract payment term such as "2/15 net 30", and given a payment timing and time value of money scenario, be able to determine the method of payment that is economically most advantageous under these terms.
S	Be able to explain contract payment terms and how they may expose the parties to risk (e.g., payment not commensurate with work performed, unbalancing, etc.).
S	Be able to describe the risks of various contract types when markets are not competitive.
S	Integrated project control:
S	Be able to explain the basic mechanics of how the project control process might be integrated between parties to each type of contract. (e.g., how to measure and report progress, integrate schedules, etc.).
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes and claims (also see Change Management).
S	Be able to describe how contracting various PRM roles and responsibilities may affect the performance of the PRM process and may lead to systemic risks due to complexity, delay, poor communication, biases, and so on.

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