AACE® INTERNATIONAL

DECISION AND RISK MANAGEMENT PROFESSIONAL

CERTIFICATION STUDY GUIDE

SECOND EDITION

DRMP

A PRODUCT OF AACE INTERNATIONAL

Decision and Risk Management Professional (DRMP)
Certification Study Guide

2024

Decision and Risk Management Professional (DRMP) Certification Study Guide

Second Edition

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PREFACE TO THE SECOND EDITION

This edition of the *Decision and Risk Management Professional (DRMP) Certification Study Guide* is an update of the 2013 edition to *DRMP Certification Study Guide* and provides references to the technical body of knowledge generated by AACE International community in the field of decision and risk management through December 2023.

Since the first edition, the following resources have been updated and/or added to technical body of knowledge at AACE International:

1. 13 existing RPs that were referenced in the 2013 DRMP Certification Study Guide have been updated.
2. 20 new RPs have been added that are related to cost and schedule risk analysis, including contract change management.
3. Four new AACE International Recommended Practices related in the field of decision analysis and management, out of which:
    - *85R-14: Use of Decision Tree in Decision Making, published,*
    - *131R-23, Introduction to Fault Tree Analysis for Projects (Currently under review by Technical Board for Publication),*
    - *133R-23, Using Decision Analysis Methodologies to Enhance Decision Quality (Currently under review by Technical Board for Publication).*
    - *RM-16 Tools and Methodologies for Developing Decision Support Packages (currently under review by DRM Subcommittee)*
4. Two new AACE International Professional Guidance Documents.
    - **Professional Guidance Document PGD 02**: *Guide to Cost Estimate Classification (August 2022. This is a living document and subject to change as new RPs become available: Professional Guidance Document No. 01 - Guide to Cost Estimate Classification Systems (aacei.org).*
    - **Professional Guidance Document PGD 02**: *Guide to Quantitative Risk Analysis (August 2022. This is a living document and subject to change as new RPs become available: Professional Guidance Document No. 02 - Guide to Quantitative Risk Analysis (aacei.org).*
5. Other reference materials such as ISO Guide, NDIA EIA-748 Intent Guide, SAVE International's Value Methodology Glossary of Terms have also gone through their respective revisions.

Accordingly, the questions databank created for the DRMP Examination have been revised to incorporate the content reflected in the updated and newer RPs published over the period.

What changes have been introduced in the relaunched DRMP Certification Examination?

1. As stated above, the existing questions databank maintained for the DRMP Examination have been revised to incorporate the content reflected in the updated RPs.
2. Additional questions have been developed and added to the DRMP questions databank to incorporate the content reflected in the newer RPs published since 2013, particularly in the field of decision analysis and management.
3. Additional Memo (communications skills & knowledge) Questions have been developed to make fair representation of the body of knowledge in the decision analysis and management

field. Candidates now will have opportunity to select either the “risk” related Memo or “decision” related Memo in the communication skills section of the exam.

4. All the questions in the entire databank have been reviewed and revised as necessary to bring clarity and remove any ambiguity.
5. The questions used for any one set of DRMP Examination are so selected that they make a proportionate representation of the knowledge tested from each area of competency within the decision and risk management field covered in this Study Guide.

What aspects have stayed consistent in the relaunched DRMP Certification Examination?

1. The basic structure of the exam remains the same:
    - Five-hour computer-based test.
    - 119 multiple choice and scenario questions
    - One Memo Question related to communication skills.
2. The basic structure of the areas of competency (and their subset) tested remains the same:
    - DRM Supporting skills and knowledge,
    - Risk management skills and knowledge,
    - Decision management skills and knowledge
    - Other functional skills and knowledge, and
    - Communication skills (Memo Question)
3. The mix of questions with regard to the level of difficulty in all areas of competency remain the same. For each area of competency, the Examination set includes a good mix of questions that test fundamental knowledge of a subject, moving on to professional level proficiency through expertise level, which comes through experience.

To what extent does the DRMP Certification Study Guide delve into specific details?

To answer this question, it is important to understand that a DRMP is a senior-level practitioner with business experience in life cycle asset and project management with demonstrated knowledge and skills ranging from analytical to socio/psychological to management. A DRMP is expected to have an extensive technical experience in specialized tools and services such as decision analysis, cost risk and uncertainty analysis, and schedule risk analysis.

Hence, it is impractical for the DRMP Certification Study Guide to encompass every facet or intricate detail of the decision and risk management field within a single volume. As the title suggests, it serves as a study guide directing readers to pertinent resources within the technical body of knowledge generated and compiled by AACE International, in an organized manner. The purpose of this study guide is to fulfill the following objectives:

1. Provide comprehensive information about the DRMP Certification Examination, outlining its structure and the areas of competency under assessment. This aims to equip prospective candidates with a clear understanding of the examination's expectations.
2. Present concise and introductory content for each competency area within the realm of DRM, offering readers a pathway to explore further through additional resource materials. Chapters 1 to 4 provide a brief overview of each significant competency area.
3. Incorporate a set of sample questions for each primary competency area, illustrating the

question types that candidates can anticipate in the DRMP Examination.

4. Provide a compilation of references, encompassing AACE RPs, Professional Practice Guides (PPGs), Professional Guidance Documents (PGDs), and other pertinent resources. These references serve as invaluable assets, housing an extensive body of knowledge in the domain of DRM. AACE RPs, in particular, undergo rigorous peer and public review, ensuring their technical contents are robust. Each RP stands as a comprehensive document. Moreover, these references serve as the source materials for examination questions, reinforcing their significance.

Therefore, when taken together, the DRMP Certification Study Guide can prove to be an invaluable asset for a prospective candidate contemplating taking the DRMP Examination.

What is the process that AACE International follows in developing, administering, and offering a certification?

To answer that question, it is important to understand the functioning of the three associated boards within AACE International: Technical, Education & Certification (also referred to as TEC). The following provides brief description of the role played by each associated board, and a newly established Certification Institute:

- ***Technical Board*** *is responsible for establishing the scope and definition of cost engineering, approving the association's recommended practices, and oversees the technical program of the annual Conference & Expo. The Technical Board is responsible for planning, facilitating the development and maintenance of, promoting, and monitoring the association's technical products and activities.*
- ***Education Board*** *is responsible for providing educational opportunities for the advancement of cost engineering professionals. The Education Board directs the development, review, and maintenance of education materials and fosters relationships through synchronous and asynchronous opportunities in the primary areas of certification review, professional development and career pathing, and higher education.*
- ***Certification Board*** *is responsible for planning, directing, and administering the AACE certification programs through the authority granted by the AACE Certification Institute Board of Directors. The Certification Board writes the certification examination questions and evaluates the performance of individuals who take the examinations.*
- ***Certification Institute*** *develops, oversees, and manages the AACE professional certification program associated with Total Cost Management and related practices. It promotes certifications to individuals and businesses in furtherance of the cost management profession. The Institute functions under its own volunteer Board of Directors and provides the strategic direction of the cert program, working in alignment with the Certification Associate Board.*

Finally, what other resources are out there that I can utilize for my preparation for the DRMP Certification Examination?

Education Board has a list of Approved Education Providers (AEPs) who develop and teach course materials for AACE Certifications. At the time of writing this edition, there are currently no AEPs that offer course materials for the DRMP Certification. Be in the lookout by periodically checking the following links.

- *AEP Course Providers (aacei.org)*

- *Approved Education Providers (aacei.org)*

PREFACE TO THE FIRST EDITION

AACE International developed the "**Decision and Risk Management Professional (DRMP) Certification Study Guide**" for two reasons. First, to aid professionals studying for AACE International's (AACE) specialty certification in decision and risk management (DRM). Second, to assemble and summarize various topics considered essential for decision and risk management professional knowledge, as outlined in AACE International's **Recommended Practice 11R-88**, "*Required Skills and Knowledge of Cost Engineering*" and included in the current edition of AACE International's "**Skills and Knowledge of Cost Engineering**."

The "**Decision and Risk Management Professional Certification Study Guide**" (study guide) serves the needs of DRM professionals who are preparing to take the AACE International DRMP certification examination. It is organized in a concise and easy-to-follow format and covers the major skills and knowledge used by a DRM professional.

The information contained in the study guide parallels the related topics of the "**Skills and Knowledge of Cost Engineering**" and the **-CCP Certification Study Guide**." These publications can be combined for a course of study in both cost engineering and decision and risk management, which include sample problems related to the subject matter.

Most terms and phrases incorporated in the study guide are generic to the profession; where applicable, however, professionals should understand the definitions provided in AACE International's **Recommended Practice 10S-90** and the terms found in the glossary of this study guide. The terms and phrases used in industry and software may not conform to the readers' understanding, so consult the DRMP glossary found in Appendix A.

The goal of the AACE International Education Board is continually to improve this publication, making it a living document that will be revised as needed to support the DRMP exam, while maintaining its strengths. AACE's Education Board encourages everyone to offer comments and suggestions for improvements to future editions; please forward comments to the AACE International Education Board.

Introduction to the DRMP™ Certification Study Guide

This is a study guide for the AACE International (AACE) Decision and Risk Management Professional (DRMP) certification examination.

This study guide follows a systematic approach in its development:

1. It establishes DRM terminology, ensuring its use is consistent with AACE International's cost engineering terminology (**Recommended Practice 10S-90**);
2. It follows AACE International's Recommended Practices related to DRM review and process;
3. It ensures consistency with AACE International's **Total Cost Management (TCM) Framework**, as summarized in Figure 1; and
4. It ensures consistency with AACE International's **Skills and Knowledge of Cost Engineering**, as summarized in Figure 2.

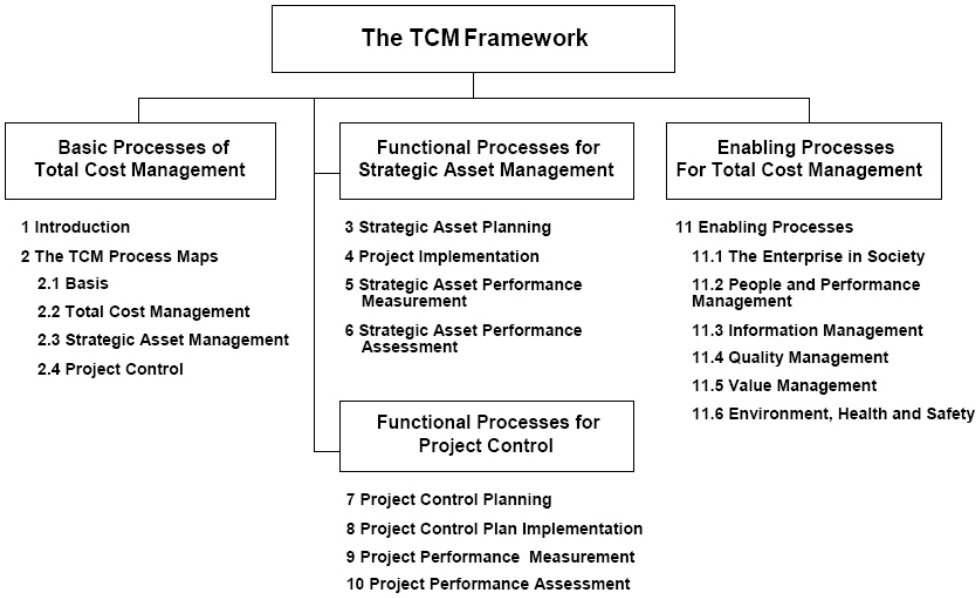

Figure 1—The Outline Structure of AACE's TCM Framework

The **TCM Framework** is based on a series of integrated processes, two of which are fundamental to DRMP certification: investment decision making (section 3.3) and risk management (section 7.6); these are sub-elements of chapters 3 and 7. All processes in TCM are integrated, and decision-making and risk management are linked to all the chapters of the **TCM Framework**. Investment decision-making and risk management, similarly, are distinct elements of the **Skills and Knowledge of Decision and Risk Management (RP 71R-12)**, as outlined in Figure 2; decision and risk management professionals must have skills and knowledge in most of the other elements of Figure 2, just as cost engineering professionals must have skills and knowledge in decision and risk management.

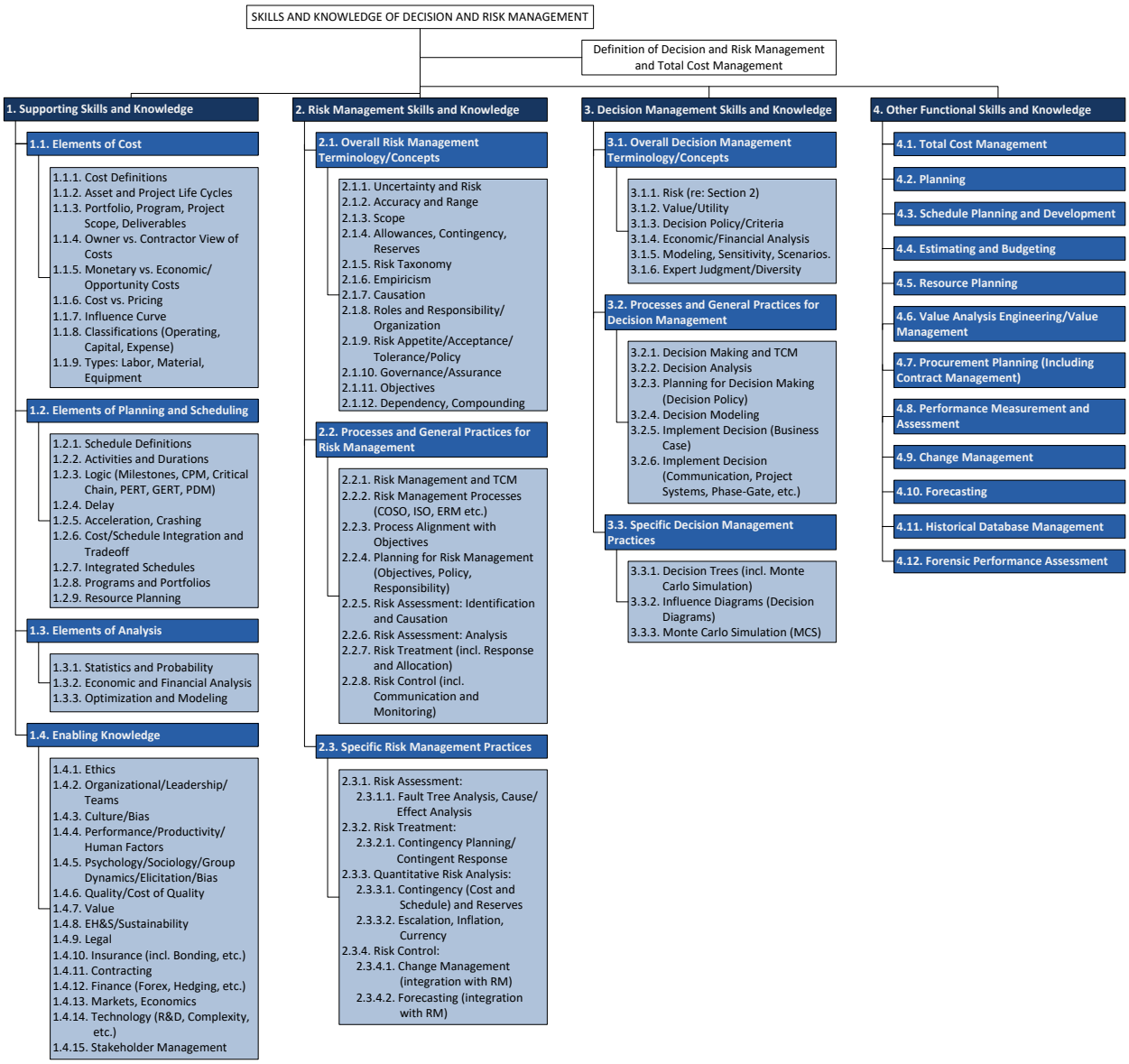

Figure 2—Outline of Skills and Knowledge of Decision and Risk Management (RP 71R-12).

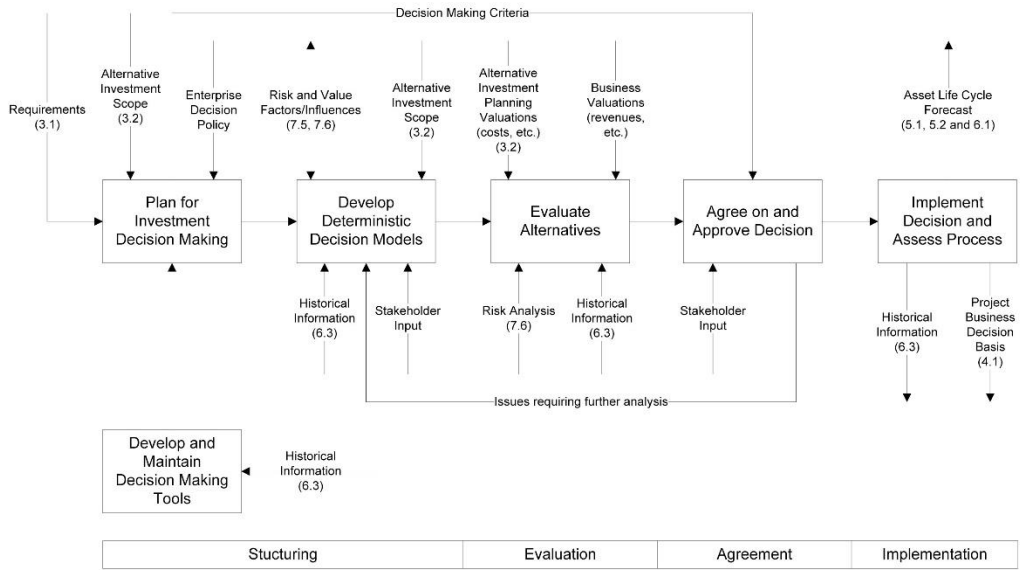

Figure 3—The TCM Framework Process Map for Investment Decision Making (Section 3.3)

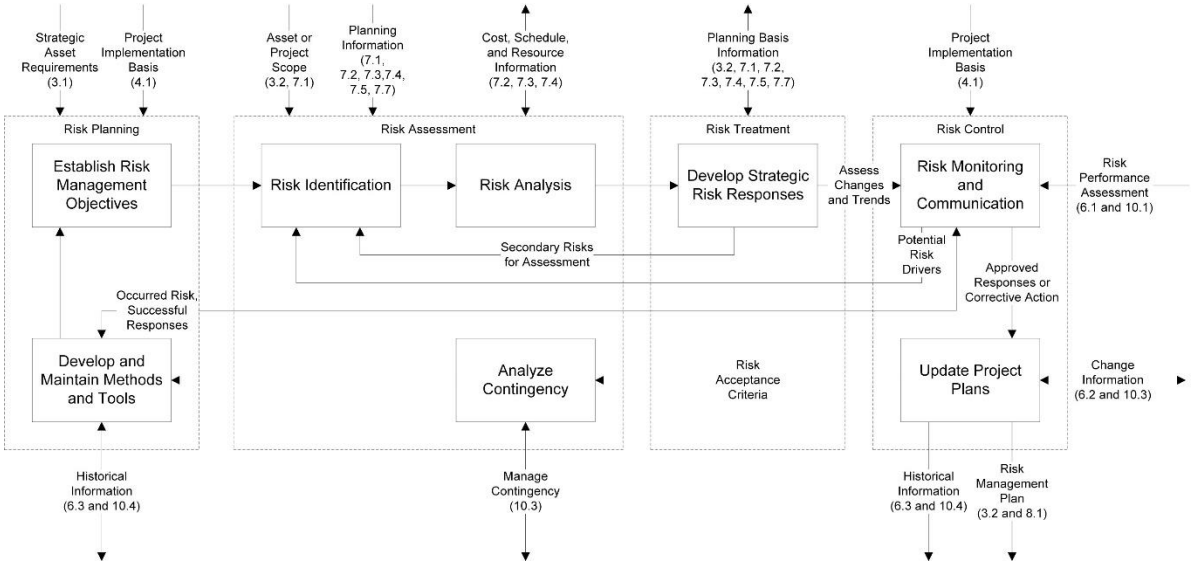

Figure 4—The TCM Framework Process Map for Risk Management (Section 7.6)

The overall learning objectives of this study guide are:

- Understand the basis of decision and risk management within the total cost management framework.
- Understand the evolution of decision and risk management.
- Describe what is essential to planning and implementing a decision and risk management process and apply its practices within a capital management or project organization in various enterprise settings.

- Understand the essentials of decision and risk management as they apply to many total cost management processes; and
- Provide the basis for AACE International's DRMP certification within the total cost management framework as summarized in Figure 2.

Following is a list of references that provide the basis of knowledge outlined in this study guide, which can be downloaded from *Publications - Recommended Practices | AACE (pathlms.com):*

1. AACE International **Recommended Practice 10S-90**, *Cost Engineering Terminology (December 2023)*.
2. AACE International **Recommended Practice 11R-88**, *Required Skills and Knowledge of Cost Engineering (June 2013)*.
3. AACE International **Recommended Practice 14R-90**, *Responsibility and Required Skills for a Planning and Scheduling Professional (August 2020)*.
4. AACE International **Recommended Practice 18R-97**, *Cost Estimate Classification System–As Applied in Engineering, Procurement and Construction for the Process Industries (August 2020)*.
5. AACE International **Recommended Practice 23R-02**, *Planning & Scheduling Identification of Activities (May 2007)*.
6. AACE International **Recommended Practice 24R-03**, *Planning & Scheduling, Developing Activity Logic (March 2024)*.
7. AACE International **Recommended Practice 27R-03**, *Schedule Classification System (November 2010).*
8. AACE International **Recommended Practice 40R-08**, *Contingency Estimating: General Principles (June 2008)*.
9. AACE International **Recommended Practice 41R-08**, *Understanding Estimate Ranging (February 2022)*.
10. AACE International **Recommended Practice 42R-08**, *Risk Analysis and Contingency Determination Using Parametric Estimating (May 2021)*.
11. AACE International **Recommended Practice 43R-08**, *Risk Analysis and Contingency. Determination Using Parametric Estimating–Example Models as Applied for the Process Industries (December 2011)*.
12. AACE International **Recommended Practice 44R-08**, *Risk Analysis and Contingency Determination Using Expected Values (May 2021)*.
13. AACE International **Recommended Practice 47R-11**, *Cost Estimate Classification System–As Applied in Engineering, Procurement and Construction for the Mining and Mineral Processing Industries (August 2020)*.
14. AACE International **Recommended Practice 52R-06**, *Prospective Time Impact Analysis–As Applied in Construction (May 2017)*.
15. AACE International **Recommended Practice 56R-08**, *Cost Estimate Classification System– As Applied for the Building and General Construction Industries (August 2020)*.
16. AACE International **Recommended Practice 57R-09**, *Integrated Cost and Schedule Risk Analysis Using Monte Carlo Simulation of a CPM Model (October 2022)*.
17. AACE International **Recommended Practice 58R-10**, *Escalation Principles and Methods Using Indices (May 2011)*.
18. AACE International **Recommended Practice 62R-11**, *Risk Assessment: Identification and Qualitative Analysis (February 2022).*
19. AACE International **Recommended Practice 63R-11**, *Risk Treatment (August 2012).*

20. AACE International **Recommended Practice 64R-11**, *CPM Schedule Risk Modeling and Analysis: Special Considerations (May 2012)*.
21. AACE International **Recommended Practice 65R-11**, *Integrated Cost and Schedule Risk Analysis and Contingency Determination Using Expected Value (May 2021)*.
22. AACE International **Recommended Practice 66R-11**, *Selecting Probability Distribution Functions for Use in Cost and Schedule Risk Simulation Models (August 2012).*
23. AACE International **Recommended Practice 67R-11**, *Contract Risk Allocation – As Applied in Engineering Procurement, and Construction (January 2014).*
24. AACE International **Recommended Practice 68R-11**, *Escalation Estimating Using Indices and Monte Carlo Simulation (May 2012)*.
25. AACE International **Recommended Practice 69R-12**, *Cost Estimate Classification System–As Applied in Engineering, Procurement and Construction for the Hydropower Industries (August 2020)*
26. AACE International **Recommended Practice 70R-12**, *Principles of Schedule Contingency Management – As Applied in Engineering, Procurement and Construction (October 2013)*
27. AACE International **Recommend Practice 71R-12,** *Required Skills and knowledge of Decision and Risk Management (June 2013; May 2024).*
28. AACE International **Recommend Practice 72R-12,** *Developing a Project Risk Management Plan (April 2013).*
29. AACE International **Recommend Practice 75R-15,** *Schedule and Cost Reserves within the Framework of EIA-748 (November 2020).*
30. AACE International **Recommend Practice 77R-15,** *Quality Control/Quality Assurance for Risk Management (June 2016).*
31. AACE International **Recommend Practice 80R-13,** *Estimate at Completion (December 2019).*
32. AACE International **Recommend Practice 83-13,** *Organizational Breakdown Structure and Responsibility Assignment Matrix (May 2014).*
33. AACE International **Recommend Practice 85R-14,** *Use of Decision Tree in Decision Making (November 2014).*
34. AACE International **Recommend Practice 86R-14,** *Variance Analysis & Reporting (October 2015).*
35. AACE International **Recommend Practice 89R-16,** *Management Summary Schedule (October 2018).*
36. AACE International **Recommend Practice 92R-17,** *Analyzing Near Critical Paths (October 2017).*
37.
38. AACE International **Recommend Practice 100R-19,** *Contract Change Management – As Applied in Engineering, Procurement, and Construction (February 2020).*
39. AACE International **Recommend Practice 106R-19,** *Basis of Estimate – As Applied in Engineering, Procurement, and Construction for Process Industries (August 2021).*
40. AACE International **Recommend Practice 109R-19,** *Schedule Change Management – As Applied in Construction Industry (January 2021).*
41. AACE International **Recommended Practice 113R-20**, *Integrated Cost and Schedule Risk Analysis and Contingency Determination Using Combined Parametric and Expected Value (May 2021)*.
42. AACE International **Recommended Practice 117R-21**, *Integrated Cost and Schedule Risk Analysis and Contingency Determination Using Combined Parametric Modeling and Monte Carlo Simulation of a CPM Model (August 2022)*.
43. AACE International **Recommended Practice 118R-21**, *Cost Risk Analysis and Contingency Determination Using Estimate Ranging for Inherent Risks with Monte Carlo Simulation (October 2022)*.

44. AACE International **Recommended Practice 119R-21**, *Cost Estimate Accuracy Range and Contingency Determination Using Tables Derived from Parametric Risk Models (November 2022)*.
45. AACE International **Recommended Practice 122R-22**, *Quantitative Risk Analysis Maturity Model (October 2022)*.
46. AACE International **Recommended Practice 123R-21**, *Integrated Cost and Schedule Risk Analysis and Contingency Determination Using Estimate Ranging and Expected Value with Monte Carlo Simulation (August 2023)*.
47. AACE International **Recommended Practice 131R-23,** *Introduction to Fault Tree Analysis for Projects (Currently under review by Tech Board for Publication)*.
48. AACE International **Recommended Practice 132R-23,** *Schedule Risk Analysis Maturity Model (Currently under review by Technical Board for Posting for Public Review)*.
49. AACE International **Recommended Practice 133R-23**, *Using Decision Analysis Methodologies to Enhance Decision Quality (Currently under review by Technical Board for Publication)*.
50. AACE International **Recommended Practice RM-16** Tools and Methodologies for Developing Decision Support Packages (currently under review by DRM Subcommittee)
51. Amos, S. (Ed.). **Skills & Knowledge of Cost Engineering**, *6th Edition*. (2015).
52. Brady, David C (Ed.), AACE **Professional Practice Guide No. 2**, **Decision and Risk Management**, *3rd Edition*, (2012).
53. International Standards Organization (ISO), **ISO Guide 73** *Risk Management Vocabulary - Guidelines for use in standards,* (2009).
54. Stephenson, H. Lance (Ed.). **Total Cost Management Framework: An Integrated Approach to Portfolio, Program, and Project Management**, (2015).
55. Hastak, Makarand, PhD **CCP Certification Study Guide**,2nd *Edition*. (See especially Section 6, *Economic Analysis Statistics, Probability and Risk* (2016).
56. Uppal, Kul (Ed.), **AACE Professional Practice Guide No. 8, Contingency**, *4th Edition*, (2022).
57. **Earned Value Management Systems, EIA-748 Intent Guide**, National Defense Industry Association (NDIA), Arlington VA. (2018).
58. SAVE International, **Value Methodology Glossary of Terms** (*Glossary*), 2020.
59. AACE International **Professional Guidance Document PGD 01**: *Guide to Cost Estimate Classification (August 2022. This is a living document and subject to change as new RPs become available: Professional Guidance Document No. 01 - Guide to Cost Estimate Classification Systems (aacei.org)*
    AACE International **Professional Guidance Document PGD 02**: *Guide to Quantitative Risk Analysis (August 2022. This is a living document and subject to change as new RPs become available: Professional Guidance Document No. 02 - Guide to Quantitative Risk Analysis (aacei.org)*

This study guide assumes candidates have a basic knowledge of DRM; it addresses DRM knowledge and skills that are non-industry specific. The study guide further aims to help candidates learn basic terminology, processes, and practices for decision and risk management. A candidate's company or industry, however, may dictate or emphasize other DRM processes for capital asset, project, program, or portfolio management.

The study guide is organized according to decision and risk management body of knowledge, described at the beginning of each section. The recommended examination preparation includes a review of many of the references listed above. Candidates must also draw from their personal decision and risk management and cost engineering experience.

What is Decision and Risk Management?

Importance of Decision and Risk Management (DRM) in Skills and Knowledge Certification

In the asset and project management arena, as covered in this study guide, making decisions and managing risks are largely inseparable. While they can and are shown separately in processes such as total cost management, in fact, quality decisions of any complexity cannot be made effectively without considering risks and all risk processes support decision-making e.g., to treat price, or otherwise to deal with risks, in plans and actions. The decisions may be of minor or major consequence, from deciding on a risk mitigation action, to funding a mega-project, and the risks considered in any decision may similarly be of minor or major consequence. In any case, decision and risk management must be combined in a meaningful body of knowledge.

In terms of relative importance, decision-making is the nexus of AACE International's total cost management framework. Decision-making is the link between the total cost management strategic asset management and project control processes; it leads to project, program, or portfolio initiation. Research shows that the success or profitability of a project is largely determined by the quality of the sanction decision and the planning and analysis behind it, including risk analysis. Once the asset-, portfolio-, program-, project-, or activity-decision is made, failure to manage risks during execution can lead to loss of planned value. Failure to manage risks can further diminish success of the specific work or the profitability of the entire enterprise, depending on the scope and impact of the risk. So, decision-making and risk management are entwined in the asset and project management and are equally important.

Brief History

Decision and risk management is as old as human history. Consider this quote from Agricola's "De Re Metallica" of 1556, one of the first practical texts on industrial methods, in this case mining and chemistry, "the man who, in common with others, has laid out his money on several mines in a region renowned for its wealth of metals, rarely spends it in vain, for fortune usually responds to his hopes in part. For when out of twelve veins in which he has a joint interest one yields an abundance of metals, it not only gives back to the owner the money he has spent, but also gives a profit besides; certainly there will be for him rich and profitable mining, if of the whole number, three, or four, or more veins should yield metal."[1] Here we find quantitatively sound investment decision-making advice that considers profitability (opportunity) and risk management. The text provides similar examples from Roman history as well.

Several centuries later, the concept of the consideration of risks in market economics is well established as exemplified in Adam Smith's 1776 treatise on the "Wealth of Nations," e.g., "The ordinary rate of profit always rises more or less with the risk. It does not; however, seem to rise in proportion to it, or so as to compensate it completely."[2]

Decision and risk management as processes and business functions began to evolve with the development of industrial engineering and quality management as exemplified by the quality and continuous improvement models of Dr. Walter Shewhart whose Plan-Do-Check-Act (PDCA) of the 1920s is the

[1] Hoover, Herbert. and L. Hoover, "De Re Metallica: Translated From the First Latin Edition of 1556", The Mining Magazine, London, 1912.

[2] Smith, Adam, An Inquiry into the Nature and Causes of the Wealth of Nations", 1776.

foundation of AACE International's total cost management framework. By the 1940s, references to "risk management" as a distinct business function became more common (albeit often in the context of marketing or insurance). As post-war capital investment boomed in the 1950s, so too did interest in capital investment and project risks.

Arguably, AACE International's founding in 1956 can be ascribed to a need to better understand capital investment economics and to make better decisions in consideration of project risks and uncertainty. AACE International's Skills and Knowledge puts a strong emphasis, as does the decision and risk management professional, on engineering economics. AACE International's first Recommended Practice in 1958 established cost estimate accuracy classifications, wherein typical "accuracy ranges" were quoted for each phase of capital project scope development.[3]

The development of robust project phase-gate (or stage-gate) scope development processes (covered in TCM section 4.1), which have the sole purpose of methodically reducing the uncertainty around investment decisions, is one of the industry's most significant and effective decision and risk management achievements. This work started with the previously referenced estimate classifications and was supported by the ground-breaking empirical cost risk research of one of AACE International's founders, Mr. John Hackney, in the 1960s and many others (RAND, CII, etc.) through the 1980s.

Methodical schedule risk analysis began to evolve during this period. The Program Evaluation and Review Technique (PERT) was developed by the U.S. Navy in 1958 to manage the Polaris Missile Program. Its objective was to simulate the schedule risk of the missile research and development program work using a flow diagram technique that, in turn, lent itself to scheduling and network analysis.[4]

By the late 1980s, software to perform Monte Carlo simulation (MCS) using personal computer-based spreadsheets was introduced, such that when combined with estimating, scheduling, decision-tree, and other models, provided cost engineers with practical tools to perform sophisticated quantitative decision and risk analyses.[5] Formal capital asset and project decision and risk management processes, systems, tools, and organizational concepts evolved and proliferated rapidly in the 1990s.

Despite measurable improvement in project cost and schedule accuracy, however, when best practices are performed, projects and portfolio outcomes are still highly uncertain, particularly for the growing numbers of mega-industrial and public infrastructure investments. Research has increasingly turned to the field of behavioral psychology to understand better the human input to and practices of decision and risk management. The skills and knowledge of decision and risk management professionals, therefore, require an understanding of the biased and sometimes irrational behavior of stakeholders, decision makers, and team members. Research in the fields of systems engineering— complexity theory being an example—also holds promise for practical analytical tools. Decision and risk management professionals will need continually to refresh their skills and knowledge.

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[3] Gorey, J.M., "Estimate Types", **AACE Bulletin** Vol. 1 No.1, November 1958
[4] Fleming, Q. and Koppelman, J., **Earned Value Project Management**, *3rd Edition*, 2005.
[5] Hollmann, J, "*Estimate Accuracy; Facing Reality*," **Transactions**, AACE Annual Meeting, July 2012

What is Risk Management?
According to the **Total Cost Management Framework** (Section 7.6), risk management is a systematic and iterative process comprising four steps:

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

This risk management process is illustrated in Figure 4. The goal of risk management is to increase the probability that a planned asset, project, or portfolio achieves its objectives. In Total Cost Management (TCM), potential deviations from plans are all considered potentially adverse to overall performance. In this sense, perceived opportunities may also pose a threat. If properly managed, however, the project- or asset-management team may be able to capitalize on "opportune" uncertainties.

The risk management process is applied in conjunction with the other asset and project control planning processes, such as scope development, cost estimating, schedule planning, schedule development, resource planning, procurement planning, and financial systems integration. Within the context of total cost management's strategic asset management process, the term, enterprise risk management (ERM), recognizes that the risk management process should be applied to overall enterprise, portfolio, and program-level objectives, not just to a single business unit, asset, or project.

The risk management process, from a project control standpoint, is designed to address uncertainty in both project input and outcomes. The process, however, generally applies and is critical to addressing uncertainty in the input to and outcomes of any decision. As discussed in the **TCM Framework** Section 3.3 on "*Investment Decision Making*," a key challenge in strategic asset planning is bringing an awareness of risk and probability concepts to decisions, whether they result in an implemented project or not. Traditional deterministic economic analysis used in decision-making may be somewhat meaningless when there are significant risks.

Uncertainty and Risk (The Definition Debate)
An initial challenge that any decision and risk management professional must deal with is the fact that the definitions of uncertainty and risk differ among practitioners and industries. For the purpose of the risk management process within the total cost management framework, risk is defined as "an uncertain event or condition that could affect a project objective or business goal." The effect may be either positive or negative, i.e., an opportunity or threat. This definition is fairly consistent within the project management and finance fields, e.g., ISO, PMI, etc., which have achievement of a target as their goal. Other fields, however, such as safety and insurance, tend to equate risk and uncertainty with negative effects or threats.

To summarize the various views, an early paper by AACE International defined risk as "an ambiguous term that can mean any of the following:

1. All uncertainty (threats and opportunities);
2. Undesirable outcomes of uncertainty (risks + opportunities);
3. The net impact or effect of uncertainty (threats - opportunities).

The paper further recommended that "the convention used in any work should be clearly stated to avoid misunderstandings."[6] This is still sound advice. The **Total Cost Management Framework** provides extensive coverage of the "definition debate," which has many points of view that DRMP candidates must be aware of.

What is Decision Management?

Total cost management investment decision-making is a process for analyzing investment alternatives and determining whether, how, and when to allocate the limited resources of the enterprise. This process is illustrated in Figure 3. While the total cost management section on decision-making specifically addresses investment decisions during enterprise planning, e.g., capital planning and budgeting, the general process is applicable to other strategic or tactical decisions that may be made in any process described in the **TCM Framework**. Decision management can be viewed as a systematic way of planning, making, implementing, monitoring, and improving major investment decisions; the process of decision-making, however, and the practices of decision analysis in consideration of risk can be applied to any decision, e.g., to take a corrective action as part of project control, for which an objective methodology is practical.

For major investment decisions, the primary input to the investment decision-making process is the scope description for one or more asset solutions that satisfy requirements. The output of the investment decision-making process is a defined scope of the selected alternative and the assumptions, i.e., business decision basis or business case, upon which the investment decision was made. This output information is the basis of the project implementation process (**TCM Framework**, *Section 4.1*, *Project Implementation*, phase-gate scope development processes, as well as the basis for asset performance measurement and assessment).

For non-project alternatives, the output is the basis for implementing asset changes, e.g., a change to process activities, etc. Decision and risk management in total cost management tends to focus on for-profit corporations since the enterprise context is focused on maximizing wealth creation as the dominant objective. Profitability is often the key outcome metric of interest. Despite this focus, the total cost management investment decision-making process applies to techniques useful for evaluations in small business, not-for-profit organizations, government, and personal lives.

The prevalent general methodology for decision-making (the focus of **TCM Framework**, Section 3.3) is decision analysis (DA). This is a systematic and typically quantitative process for selecting the optimal of two or more alternatives to address a problem or opportunity; such alternatives can take the form of two or more actions—buy vs. don't buy, divest vs. don't divest—or two or more options—a choice between projects, equipment types, vendors, contractors, etc. Alternatives can also be high-profile and strategic, such as whether to divest a corporate subsidiary or infuse it with additional capital in an attempt to increase competitiveness and profitability, or as low-level as the selection between two sources for parts. The tools of decision analysis are scalable, the same methods and techniques can be applied across a full spectrum of decision complexities and sizes.

Decision and economic analysis often consider economic costs; decision analysis is a type of economic analysis. Economic costs are a relative view of costs rather than an absolute measure of money. In this sense, economic costs recognize that costs represent opportunities lost, or opportunity costs, and that

[6] AACE International. "*Risk Management Dictionary*," **Cost Engineering**, vol. 42, (2000).

the value of money is relative to the time, currency, and context in which it is expended, how it is accounted for and taxed, and the definition of value that is applied in the valuation process.

Decision analysis as generally applied is a process comprising four steps:

1. **Structuring**: identify and frame the problem or opportunity;
2. **Evaluation**: analyze the alternatives identified in structuring;
3. **Agreement**: develop formal agreement on the selected alternative from evaluation, develop the implementation plan, obtain decision-maker approval; and
4. **Implementation**: implement the selected alternative, and perform continuous improvement of the decision-analysis process.

Structuring in total cost management (TCM) is primarily addressed in requirements elicitation and asset planning processes (**TCM Framework**, *Sections 3.1 and 3.2*). Implementation in decision analysis (DA) is primarily addressed in **TCM Framework**, *Section 4.1*, on project implementation. The decision management professional applying decision analysis is therefore dealing with all these processes as an integrated set, not just decision-making by itself.

Decision analysis should be initiated whenever a problem or opportunity arises for which one solution is clearly not the best choice. Care must be taken to ensure that one alternative or solution is not simply assumed to be the best one. The apparent best alternative or solution often contains hidden drawbacks or deficiencies, which are only identified through a detailed decision analysis. An apparent subpar solution or alternative, conversely, might hide significant improvements compared to one or more other alternatives. The value-engineering process (**TCM Framework**, *Section 7.5*) is integral to decision analysis.

The purpose of the decision analysis process is to facilitate good decision-making. A good decision is one that is logical and consistent with the strategies and objectives of the enterprise, is consistent with the information available at the time, and is likely, therefore, to be compatible with the decision policy of the enterprise. Owing to inherent uncertainty, a good decision does not guarantee a good outcome, but making good decisions over the long term can be expected to maximize the progress of the enterprise toward its objectives.

Decision analysis is not prescriptive as to specific evaluation techniques. Methods such as decision trees, multi-criteria decision analysis (MCDA), and others are common. To deal with uncertainty, the best methods are typically probabilistic in nature.

Conclusion

The preceding discussions are only highlights of the decision and risk management processes, practices, and terms. For more complete coverage, students are referred to the appropriate sections of the **TCM Framework**.

DRMP Certification Examination Structure

Introduction

To be certified as a Decision and Risk Management Professional (DRMP), a candidate must meet the minimum eligibility requirements and successfully pass a written examination as determined by the AACE International Certification Board. This study guide provides the information needed to prepare for the DRMP examination.

Basis of the Examination

The purpose of any professional certification or licensing program is to provide a mechanism to formally and objectively evaluate and publicly recognize the capabilities of an individual in a defined skill area. Certification as a Decision and Risk Management Professional (DRMP) recognizes certificate holders who have demonstrated their expertise in decision and risk management (DRM), which includes the following:

- Decision and risk management supporting skills and knowledge,
- Risk management skills and knowledge,
- Decision management skills and knowledge, and
- Other functional skills and knowledge.

To define decision and risk management more specifically in terms of expected skills and knowledge, AACE International has published **Recommended Practices**. Decision and risk management is a sub-element of cost engineering as applied to the process of total cost management, which is a dynamic, integrated process incorporating many functions and is affected by advances in philosophies, methodologies, and technology. A professional cost engineer specializing in DRM is expected to keep abreast of these advances and demonstrate this knowledge in the examination.

In summary, the definition of DRM and **Recommended Practice 11R-88***,* "*Required Skills and Knowledge of Cost Engineering*" (DRM portion), form the basis of the DRMP certification examination, which addresses the following:

- Minimum knowledge covered by the basic skills documents; and
- Advanced knowledge based upon DRM experience.

Examination Structure

The DRMP exam contains multiple choice questions and a written memo assignment. The multiple-choice questions and the written assignment scores are averaged together for an overall exam score. You must receive a minimum average of 70% in order to successfully pass the exam, as determined by the Certification Board.

1. **MULTIPLE CHOICE EXAMS**: The exam is delivered through computer based testing (CBT)* and is comprised of multiple-choice and compound, scenario questions. The topics covered in the exam are: *basic cost engineering and statistics* (**DRM Body of Knowledge**, *Section 1 and 4*); *decision and risk management practices - scenarios; and general decision and risk management practices* (**DRM Body of Knowledge**, *sections 2 and 3*).

2. **MEMO ASSIGNMENT**: The memo assignment will allow the candidate to choose from an onscreen list of suggested scenarios and will require the candidate to demonstrate professional writing skills and a general knowledge around an estimating competency. The memo will be written in the text box provided onscreen and should demonstrate a candidate's ability to organize thought and communicate effectively. The memo will need to be addressed properly, include a purpose statement, propose a solution with supporting details and include a closing statement.

The exam is closed book. Candidates are permitted to bring any style of calculator, including programmable calculators, to use during the exam.

The examination is not based upon use or knowledge of specific software, but rather embodies the knowledge and experience of a DRM practitioner using such tools. All materials provided during the examination, including work paper, must be turned in upon completion of the examination.

Recognizing that there are many industries and fields within the profession—engineering, construction, manufacturing, process facilities, mining, utilities, transportation, aerospace, environment and government—candidates can expect questions from any of these practices. The exam takes into account the fact that no one can be expected to be conversant in all practice areas through its multiple-option format and extensive use of questions of general applicability.

DRMP candidates are expected to have fairly broad skills, knowledge, and experiences in cost engineering in addition to specific DRM skills and knowledge. While it is not required, candidates will benefit from first passing the Certified Cost Professional (CCP) examination because of the exams' shared skills and knowledge of total cost management (TCM) and cost engineering in general and economic analysis in particular. However, passing the DRMP is not a substitute for nor does it indicate achievement of the CCP. DRM professionals cannot provide effective support to decision makers and project leaders without understanding the context of the relevant asset and project management process.

Decision and risk management goes beyond the CCP with respect to skills and knowledge of DRM process steps (as shown in figures Figure 3 and Figure 4) and incorporated methods such as decision analysis, risk analysis, and contingency analysis. These methods require strong quantitative skills and knowledge, particularly in the areas of probability, statistics, and modeling. Finally, communication skills are vital to making sure risks and their impacts are identified and understood, particularly among stakeholders, decision makers, and managers who have strong expectations and biases. Before investing in the effort and expense required for taking the exam, candidates should review objectively their understanding, skill, and experience of this diverse body of knowledge.

Chapter 1.0 Supporting Skills and Knowledge

Introduction

The practice of decision and risk management (DRM) takes place throughout the life cycle of asset and project management and is tied to all the processes in total cost management (TCM). The first steps in TCM, whether for an asset portfolio or for a single project, are to gather requirements for asset or project performance from varied stakeholders and to establish objectives and measures that will indicate if the requirements have been met.

Profit, usually measured in some form of return on asset investments, is the most common high-level objective and is the basis for most decisions. Profit is driven by revenue, capital, and expense costs (in TCM, cost is an investment of resources of various types such as labor and materials), and the time-value of money over the life cycle of an asset or asset portfolio. Other requirements and objectives may address quality, health, safety, environment, security, reputation, or other performance attributes of a portfolio, program, or project. The DRM professional must therefore understand both asset and project lifecycle processes and the many attributes of success to be planned, analyzed, and measured.

DRMP candidates will need to evaluate all measures using a wide variety of analytical methods. Because DRM deals with uncertainty, most of the analyses involve the application of probability and statistics. While DRMP candidates are not expected to be expert statisticians, they should be competent with the basic statistical concepts, such as common probability distribution attributes and basic descriptive statistical definitions. The probability and statistical concepts are typically applied to various analytical models of profit, e.g., NPV (net present value); cost, e.g., capital estimates; schedule, e.g., CPM schedules (critical path method); and so on. The models may be as simple as cash flow, cost and time, or as complex as multi-attribute decision-models that convert all success measures—cost, time, safety, environment, reputation, etc.—to monetary equivalents or some other common metric. Monte Carlo simulation (MCS) is often applied to the underlying analytical models. Because profit is often the ultimate decision criterion and measure at risk, DRM candidates must have strong skills and knowledge of economic and financial analysis, particularly engineering economics, e.g., NPV, applying the time-value of money. Analytical methods of systems engineering in future are likely to become more prominent as they become more practical in DRM.

The TCM processes take place in varied cultural, political, enterprise, organizational, and team settings. There are many stakeholders to be consulted, considered, and dealt with, both internal and external to the organization. These stakeholders often have competing, sometimes conflicting, needs and expectations; each brings different biases to the analysis. DRM professionals must be versed in organizational, cultural, political, behavioral, and psychological bodies of knowledge. Understanding the human dimensions of DRM is likely to become more prominent as research leads to more practical applications.

DRM professionals may be working in an asset-owner, contractor, or consulting organization. Owners tend to be more focused on the strategic asset management side of TCM, making portfolio, program, and project investment decisions; the quality of those decisions are often strong drivers of success. Contractors tend to focus on the project control side of TCM. The owner's profit derives from return on capital assets—the strategic decision is the investment decision, and the biggest risks are often market, product, and production related. Conversely, the contractor's profit derives from return on human

capital—the strategic decisions are the resourcing and bid decisions, and the biggest risks tend to be execution related. DRMP candidates must understand both perspectives.

While other AACE specialty certifications focus on one measure or sub-process of TCM—Certified Estimating Professional (CEP) on cost, Planning and Scheduling Professional (PSP) on time, Earned Value Professional (EVP) on measurement and control, Certified Forensic Cost Consultant (CFCC) on contracting—the DRMP may be the most demanding of general or supporting skills and knowledge of the entire spectrum of TCM processes (estimating, scheduling, contracting) and measures of interest (quality, cost, time, etc.). The need to understand behavioral and psychological aspects is great (performing risk elicitation, addressing decision-maker bias, etc.). The skills and knowledge portion of the **DRMP Body of Knowledge** is as broad as the CCP—with a deeper focus on probability, statistics, and DRM modeling methods on the analytical side, psychology and behavior on the management side. DRMP candidates holding CCP certifications will have a head start in preparing for the DRMP exam. The value of DRMP certification can generally be determined by the fact that top capital management and project decision-makers and leaders solicit DRMP support and input; decision and risk management is an esteemed career, in part owing to its proximity to decision-makers.

In summary, the decision and risk management professional should have a firm understanding of the following principle supporting skills and knowledge concepts:

- **Elements of Costs**

    1. Cost definitions,
    2. Asset and project life cycles,
    3. Portfolio, program, project scope, deliverables,
    4. Owner vs. contractor view of costs,
    5. Monetary vs. economic/opportunity costs,
    6. Cost vs. pricing,
    7. Influence curve,
    8. Classifications: operating, capital, expense; and
    9. Types: labor, material, equipment.

- **Elements of Planning and Scheduling**

    1. Schedule definitions,
    2. Activities and durations,
    3. Logic: milestones, CPM (critical path method), critical chain, PERT (program evaluation and review technique), GERT, PDM (precedence diagramming method),
    4. Delay,
    5. Acceleration, crashing,
    6. Cost/schedule integration and tradeoff
    7. Integrated schedules,
    8. Programs and portfolios, and
    9. Resource planning.

- **Elements of Analysis**

    1. Statistics and probability,
    2. Economic and financial analysis, and
    3. Optimization and modeling.

- **Enabling Knowledge**

    1. Ethics,
    2. Organizational/leadership/teams,
    3. Culture/bias,
    4. Performance/productivity/human factors,
    5. Psychology/sociology/group dynamics/elicitation/bias,
    6. Psychology of estimating and decision analysis,
    7. Quality/cost of quality,
    8. Value,
    9. EH&S/sustainability,
    10. Legal,
    11. Insurance (including bonding, etc.),
    12. Contracting,
    13. Finance (Forex, hedging, etc.),
    14. Markets, economics,
    15. Technology (R&D, complexity, etc.), and
    16. Stakeholder management.

Terms & Definitions to Know (Refer to *Revised 10S-90: Cost Engineering Terminology*)

- Action owner,
- Asset lifecycle,
- Capital asset,
- Cash flow,
- Cost,
- Decision analysis (DA),
- Decision and risk management (DRM),
- Ethics,
- Foreign exchange (Forex),
- Internal rate of return (IRR),
- Linear regression,
- Merge bias,
- Monte Carlo simulation (MCS),
- Net present value (NPV),
- Organization breakdown structure (OBS),
- Portfolio,
- Precedence diagramming method (PDM),
- Program,
- Program evaluation and review technique (PERT),
- Project,

- Project control (in TCM),
- Project lifecycle,
- Pricing,
- Qualitative analysis,
- Quality,
- Quantitative analysis,
- Requirements,
- Residual risk,
- Resources,
- Responsibility assignment matrix (RAM),
- Return on investment (ROI),
- Risk breakdown structure,
- Risk events,
- Risk management (RM),
- Risk owner,
- Secondary risk,
- Strategic asset management (in TCM),
- Total cost management (TCM),
- Types of risk,
- Value, and
- Work breakdown structure (WBS).

Key Points for Review

- Understand the breadth of DRMP skills and knowledge required to support all TCM processes and cost engineering functions,
- Understand the principal elements of cost and resources as related to DRM,
- Understand the principal elements of planning and scheduling as related to DRM,
- Understand the basic principles of analysis using probability and statistics in DRM,
- Understand profitability measurement concepts (IRR/NPV/ROI) with emphasis on the uncertainty aspects as related to DRM,
- Understand the optimization and modeling practices related to DRM,
- Understand the principles of ethics as required in DRM,
- Understand management theories and decision-making related to DRM,
- Understand the cultural and political drivers and biases and decision-making related to DRM,
- Understand the psychological and sociological drivers of biases related to DRM,
- Understand the relationship of DRM to quality management,
- Understand the relationship of value engineering/value management to DRM,
- Understand the role of insurance, bonds, and payment guarantees to DRM,
- Understand the relationship of contracting to DRM processes,
- Understand the relevancy of foreign exchange and currency hedging to DRM,
- Understand the relevancy of markets and economics to DRM,
- Understand the relevancy of technology and complexity to DRM, and
- Understand the relevancy of stakeholder management to DRM.

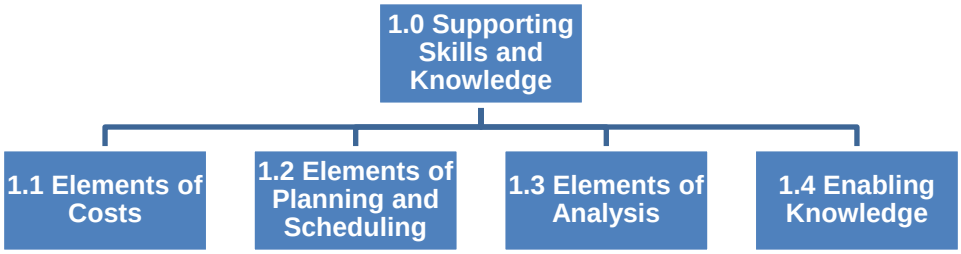

Figure 5—DRM Body of Knowledge Diagram for Supporting Skills and Knowledge