TECHNICAL MEMORANDUM
FUTURE64 COST ESTIMATING

Prepared for:	Missouri Department of Transportation
Prepared by:	HDR
Project:	Future64: Communities » Transportation » Together *Kingshighway Blvd. to Jefferson Ave.*
Date:	November 1, 2022

INTRODUCTION

The Missouri Department of Transportation (MoDOT) is performing a Planning and Environmental Linkages Study (PEL) for the I-64 Corridor from the western limit of Kingshighway Blvd to the eastern limit Jefferson Ave a distance of 2.7 miles. MoDOT has contracted a consultant team led by HDR to develop both short-term and long-term alternatives while identifying proposed actions to address asset management needs, improve operational performance and safety, and address community needs in the corridor. Conceptual alternatives will be developed, which include individual cost estimates for each alternative.

The purpose of this memorandum is to document the methodology that will be used in the preparation of the cost estimates.

COST ESTIMATING STRATEGIES AND METHODOLOGY

Cost estimating for the alternatives presented will follow practices set forth by the Association for the Advancement of Cost Estimating (AACE) Recommended Practice No. 17R-97 for Class 4 Estimates. This document is included in **Attachment A**. The AACE recommends the use of Class 4 estimates for concept studies or for feasibility, both which fit the characteristics of a PEL.

The expected level of design for the engineering alternatives presented in the PEL is 5%. This falls within the expected maturity level appropriate for a Class 4 estimate in accordance with AACE Recommended Practice No. 17R-97.

According to AACE, estimating methodologies are categorized as either stochastic or deterministic in nature. Stochastic methods utilize factors or metrics to quantify costs – as opposed to direct measures – with costs quantified based on factors gathered from past planning studies or review of previously constructed project bids. Examples of these factors may be cost-per-mile, percentage of construction cost, or cost-per-interchange. Deterministic methods quantify improvements and directly apply unit costs based on available information such as review of past project bids and similar concept study estimates. For this project, a deterministic approach will be used for those improvements which can be quantified by area, volume or length from a 5% level design and will include items such as pavement and base, retaining walls, and bridges. The remaining items will be estimated using a stochastic approach. For a complete list of these items see Table 1 – I-64 PEL Unit Costs.

Based upon review of similar planning level cost estimates and current MoDOT bid tabulations, unit costs have been developed in 2022 dollars for use on the I-64 PEL. These unit costs can be seen in Table 1 – I-64 PEL Unit Costs.

Given the nature of the urban interstate corridor, level of detail available, and volatility in the current construction market cost estimates will be prepared with 20% contingency applied to the construction and right-of-way acquisition costs of Build alternatives presented throughout.

Cost estimates for each alternative will be subtotaled based on construction costs for freeways, ramps, local roads, and bridges. The cost estimates will be used to evaluate/screen each alternative. Estimates will be developed in a manner to allow standalone projects along the corridor to be identified as future projects. These future projects may then be added to the Statewide Transportation Improvement Program (STIP). Upon completion of the cost estimates, a memorandum will be prepared to further explain the estimating methodologies used for each of the estimated components.

Table 1. I-64 PEL Unit Costs

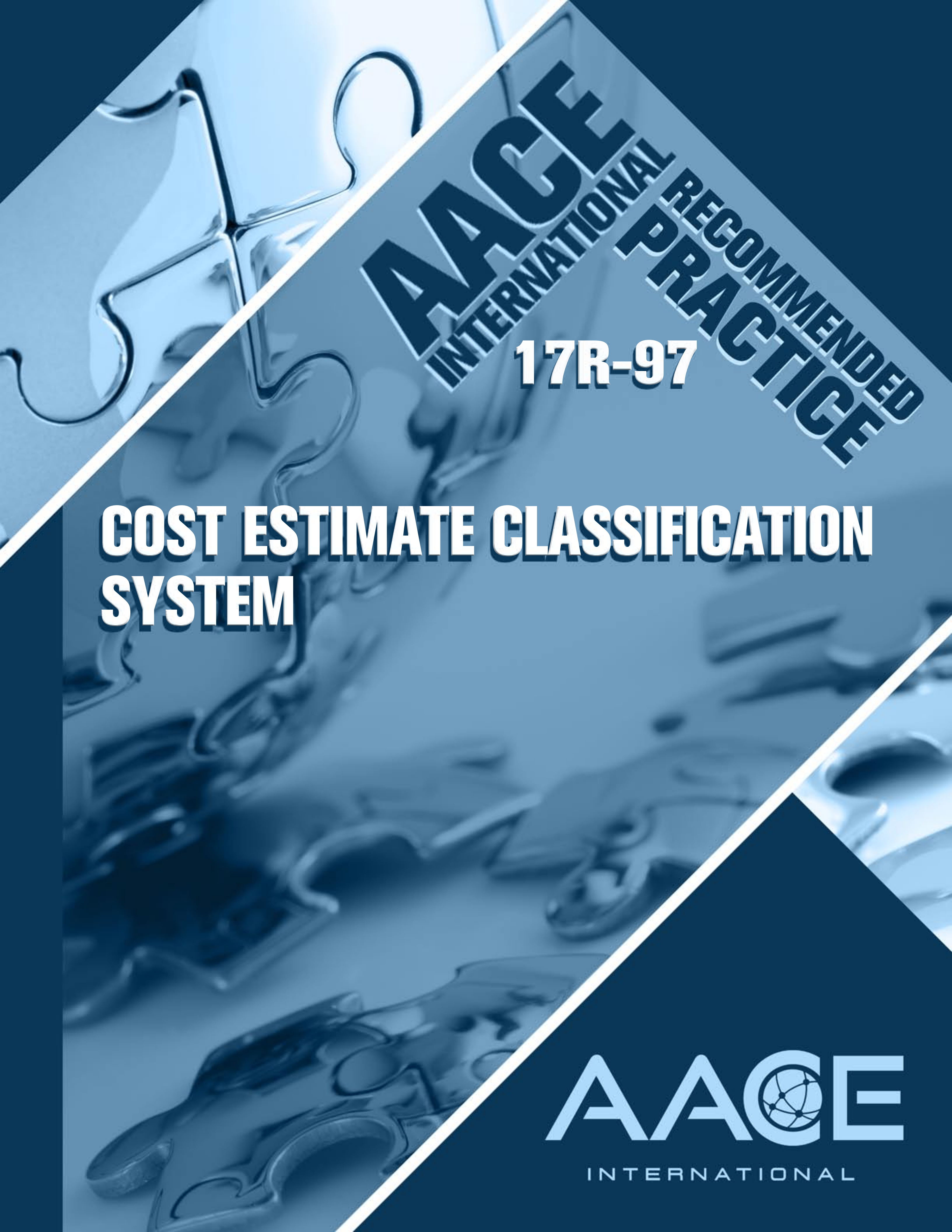
Item	Unit	$/Unit or % (2022 Dollars)	Remarks
Grading and Drainage			
Mainline Earthwork (Excavation and Embankment)	CUYD	$ 50	Centerline profile will be utilized along with typical section
Linear Grading	STA	$ 2100	For improvements without profiles
Erosion Control	MI	$ 300,000	
Fencing	LF	$ 60	
Pavement and Base			
Mainline I-64			
10.5-Inch Heavy Duty PCCP w/ Rock Fill Base	SQYD	$ 130	Assumes Full Depth Shoulders, Mainline Pavement, Ramp Pavement, and Ramp Shoulders
Permanent Concrete Barrier (B/C/D)	LF	$ 120	Applied to median and sideroad
Outer-Roads and Local Roads			
8-Inch Medium Duty PCCP w/ Rock Base	SQYD	$ 90	
Highway Lighting			
Highway Lighting	MI	$ 350,000	
Interchanges			
Sidewalk/Bike Trail & Curb Ramps	SQYD	$ 65	
Lighting & Signing	EA	$ 600,000	Includes additional lighting at non-directional interchanges and all signing for each interchange
Signalization	EA	$ 350,000	Each Intersection
Structures			
Box Culverts	SQFT	$ 200	
Cross Road Bridges	SQFT	$ 160	
Flyover - Curved Steel Bridges	SQFT	$ 350	
Bridge Removal	SQFT	$ 20	
Walls			
MSE Walls	SQFT	$ 85	Avg. height will be utilized based on length and max height
Sound Walls	SQFT	$ 100	Avg. height will be utilized
Utility Relocation			
Corridor Utility Relocation	MI	$ 500,000	Assumes most will be within ROW, Additional costs to be added for large facility relocations and itemized
ITS Relocation and Improvements	MI	$ 450,000	
Miscellaneous Costs			
Drainage	% of Roadway	15%	Includes all stormwater pipes and inlets
Removal of Improvements	% of Const.	10%	

Item	Unit	$/Unit or % (2022 Dollars)	Remarks
Traffic Control - Signing and Pavement Marking	% of Const.	2%	
MOT During Construction	% of Const.	6%	
Enhancements	% of Const.	2%	
Surveying	% of Const.	1%	
Mobilization	% of Const.	6%	
Engineering Design	% of Const.	10%	
Construction Management and Administration	% of Const.	10%	
Contingency			
Contingency	% of Subtotal of Above	20%	
Right-of-Way Costs			
Right-of-Way	TBD		To be provided by MoDOT per Scope of Services

The unit costs shown in this estimate represent an estimate of probable costs prepared in good faith and with reasonable care. HDR has no control over the costs of construction labor, materials, or equipment, nor over competitive bidding or negotiation methods and does not make any commitment or assume any duty to assure that bids or negotiated prices will not vary from this estimate of unit costs

Attachment A

AACE Recommended Practice No. 17R-97



AACE INTERNATIONAL RECOMMENDED PRACTICE

17R-97

COST ESTIMATE CLASSIFICATION SYSTEM

AACE INTERNATIONAL

AACE International Recommended Practice No. 17R-97

COST ESTIMATE CLASSIFICATION SYSTEM

TCM Framework: 7.3 – Cost Estimating and Budgeting

Rev. August 7, 2020

Note: As AACE International recommended practices evolve over time, please refer to web.aacei.org for the latest revisions.

Any terms found in AACE Recommended Practice 10S-90, *Cost Engineering Terminology*, supersede terms defined in other AACE 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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Disclaimer: The content provided by the contributors to this recommended practice is their own and does not necessarily reflect that of their employers, unless otherwise stated.

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AACE® International Recommended Practice No. 17R-97

COST ESTIMATE CLASSIFICATION SYSTEM

TCM Framework: 7.3 – Cost Estimating and Budgeting

August 7, 2020

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1. PURPOSE

As a recommended practice (RP) of AACE International, the *Cost Estimate Classification System* provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The *Cost Estimate Classification System* maps the phases and stages of project cost estimating together with a generic project scope definition maturity and quality matrix, which can be applied across a wide variety of industries.

This recommended practice has been developed in a way that:

- provides common understanding of the concepts involved with classifying project cost estimates, regardless of the type of enterprise or industry the estimates relate to;

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- fully defines and correlates the major characteristics used in classifying cost estimates so that enterprises may unambiguously determine how their practices compare to the guidelines;
- uses the maturity level of project definition deliverables as the primary characteristic to categorize estimate classes; and
- reflects generally-accepted practices in the cost engineering profession.

An intent of this document is to improve communications among all the stakeholders involved with preparing, evaluating, and using project cost estimates. The various parties that use project cost estimates often misinterpret the quality and value of the information available to prepare cost estimates, the various methods employed during the estimating process, the accuracy level expected from estimates, and the level of risk associated with estimates.

This classification RP is intended to help those involved with project estimates to avoid misinterpretation of the various classes of cost estimates and to avoid their misapplication and misrepresentation. Improving communications about estimate classifications reduces business costs and project cycle times by avoiding inappropriate business and financial decisions, actions, delays, or disputes caused by misunderstandings of cost estimates and what they are expected to represent.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes, terminology, and may classify estimates in other ways. This guideline provides a generic and generally acceptable classification system that can be used as a basis to compare against. This recommended practice should allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

2. INTRODUCTION

An AACE International guideline for cost estimate classification for the process industries was developed in the late 1960s or early 1970s, and a simplified version was adopted as an ANSI Standard Z94.0 in 1972. Those guidelines and standards enjoyed reasonably broad acceptance within the engineering and construction communities and within the process industries. However, in the 1980s, empirical research on the correlation of the maturity level of project definition and cost growth and schedule slip led to better understanding of project risks and the wide implementation of project phase or stage-gate scope development processes [3]. This recommended practice, in consideration of this research improves upon the earlier standards by:

1. providing a classification method applicable across all industries;
2. unambiguously identifying, cross-referencing, benchmarking, and empirically evaluating the multiple characteristics related to the class of cost estimate; and
3. aligning with typical phase-gate project scope definition practices.

This guideline is intended to provide a generic methodology for the classification of project cost estimates in any industry and will be supplemented with recommended practices that will provide extensions and additional detail for specific industries.

3. CLASSIFICATION METHODOLOGY

There are numerous characteristics that can be used to categorize cost estimate types. The most significant of these are the maturity level of project definition deliverables, end usage of the estimate, estimating methodology, and the effort and time needed to prepare the estimate. The primary characteristic used in this guideline to define the classification category is the maturity level of project definition deliverables. The other characteristics are secondary.

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Categorizing cost estimates by maturity level of project definition is in keeping with the AACE International philosophy of total cost management, which is a quality-driven process applied during the entire project life cycle. The discrete levels of project definition used for classifying estimates correspond to the typical phases and gates of evaluation, authorization, and execution often used by project stakeholders during a project life cycle.

	Primary Characteristic	***Secondary Characteristic***			
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical +/- range relative to index of 1 (i.e. Class 1 estimate) [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Screening or feasibility	Stochastic (factors and/or models) or judgment	4 to 20	1
Class 4	1% to 15%	Concept study or feasibility	Primarily stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget authorization or control	Mixed but primarily stochastic	2 to 6	3 to 10
Class 2	30% to 75%	Control or bid/tender	Primarily deterministic	1 to 3	5 to 20
Class 1	65% to 100%	Check estimate or bid/tender	Deterministic	1	10 to 100

Notes:
[a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50% (at an 80% confidence interval).
[b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Table 1 – Generic Cost Estimate Classification Matrix

Five cost estimate classes have been established. While the maturity level of project definition is a continuous spectrum, it was determined from benchmarking industry practices that three to five discrete categories are commonly used. Five categories are established in this guideline as it is easier to simplify by combining categories than it is to arbitrarily split a standard.

The estimate class designations are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest maturity level of project definition, and a Class 1 estimate is closest to full project definition and maturity. This arbitrary countdown approach considers that estimating is a process whereby successive estimates are prepared until a final estimate closes the process.

Table 1 provides a summary of the characteristics of the five estimate classes. The maturity level of definition is the sole determining (i.e., primary) characteristic of class. In Table 1, the maturity is roughly indicated by a % of complete definition; however, it is the maturity of the defining deliverables that is the determinant, not the percent. The specific deliverables, and their maturity or status can only be defined in the context of the specific industry project scope.

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Depending on the technical and project deliverables (and other variables) and risks associated with each estimate, the accuracy range for any particular estimate is expected to fall into the ranges identified. However, this does not preclude a specific actual project result from falling outside of the indicated ranges identified in Table 1.

4. DETERMINATION OF THE COST ESTIMATE CLASS

For a given project, the determination of the estimate class is based upon the maturity level of project definition based on the status of specific key planning and design deliverables. The percent design completion may be correlated with the status, but the percentage should not be used as the class determinate. While the determination of the status (and hence the estimate class) is somewhat subjective, having standards for the design input data, completeness and quality of the design deliverables will serve to make the determination more objective.

5. DEFINITIONS OF COST ESTIMATE CHARACTERISTICS

The following are brief discussions of the various estimate characteristics used in the estimate classification matrix. For the secondary characteristics, the overall trend of how each characteristic varies with the maturity level of project definition deliverables (the primary characteristic) is provided.

5.1. Maturity Level of Project Definition Deliverables (Primary Characteristic)

This characteristic is based upon the maturity or the extent of definition of key types of planning, design and other input information and deliverables available to the estimating process. Such inputs include project scope definition, requirements documents, specifications, project plans and schedules, drawings, calculations, learnings from past projects, reconnaissance data, and other information that must be developed to define the project. Each industry will have a typical set of deliverables that are used to support the type of estimates used in that industry. The set of deliverables becomes more definitive and complete as the level of project definition progresses; therefore, the percent completion will be somewhat correlated with the maturity level (see Table 1) However, percent completion metrics lack necessary information as to whether key deliverables have met quality goals or been completed in the proper sequence. A maturity matrix of key deliverables and their required status for each class is the recommended characteristic determinant.

5.2. End Usage (Secondary Characteristic)

The various classes (or phases) of cost estimates prepared for a project typically have different end uses or purposes. As the degree of project definition increases, the end usage of an estimate typically progresses from strategic evaluation and feasibility studies to funding authorization and budgets to project control purposes.

5.3. Estimating Methodology (Secondary Characteristic)

Estimating methodologies fall into two broad categories: stochastic and deterministic. In stochastic methods, the independent variable(s) used in the cost estimating algorithms are generally something other than a direct measure of the units of the item being estimated. The cost estimating relationships used in stochastic methods are often based on factors, metrics, models, etc. With deterministic methods, the independent variable(s) are more or less a definitive measure of the item being estimated (can include quotes, bids, etc.). A deterministic methodology reduces the level of conjecture inherent in an estimate. As the maturity level of project definition increases, the estimating methodology tends to progress from stochastic to deterministic methods.

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5.4. Expected Accuracy Range (Secondary Characteristic)

Estimate accuracy range is in indication of the degree to which the final cost outcome for a given project will vary from the estimated cost. Accuracy is traditionally expressed as a +/- percentage range around the point estimate after application of contingency, with a stated level of confidence that the actual cost outcome would fall within this range (+/- measures are a useful simplification, given that actual cost outcomes have different frequency distributions for different types of projects). As the maturity level of project definition deliverables increases, the expected accuracy of the estimate tends to improve, as indicated by a tighter +/- range.

Note that in table 1, the values in the accuracy range column do not represent + or - percentages, but instead represent an index value relative to a best range index value of 1. If, for a particular industry, a Class 1 estimate has an accuracy range of +10/-5 percent, then a Class 5 estimate in that same industry may have an accuracy range of +100/-50 percent.

In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as:

- Level of familiarity with technology.
- Unique/remote nature of project locations and conditions and the availability of reference data for those.
- Complexity of the project and its execution.
- Quality of reference cost estimating data.
- Quality of assumptions used in preparing the estimate.
- Experience and skill level of the estimator.
- Estimating techniques employed.
- Time and level of effort budgeted to prepare the estimate.
- Market and pricing conditions.
- Currency exchange.

Systemic risks such as these are often the primary driver of accuracy, especially during the early stages of project definition. As project definition progresses, project-specific risks (e.g. risk events and conditions) become more prevalent and also drive the accuracy range. Another concern in estimates is potential organizational pressure for a predetermined value that may result in a biased estimate. The goal should be to have an unbiased and objective estimate both for the base cost and for contingency. The stated estimate ranges are dependent on this premise and a realistic view of the project. Failure to appropriately address systemic risks (e.g. technical complexity) during the risk analysis process, impacts the resulting probability distribution of the estimated costs, and therefore the interpretation of estimate accuracy. [3]

5.5 Effort to Prepare Estimate (Secondary Characteristic)

The level of effort needed to prepare a given estimate is an indication of the cost, time, and resources required. The cost measure of that effort is typically expressed as a percentage of the total project costs for a given project size. As the maturity level of project definition deliverables increases, the amount of effort to prepare an estimate increases, as does its cost relative to the total project cost. The effort to develop the project deliverables is not included in the effort metrics; they only cover the cost to prepare the cost estimate itself.

6. RELATIONSHIPS AND VARIATIONS OF CHARACTERISTICS

There are a myriad of complex relationships that may be exhibited among the estimate characteristics within the estimate classifications. The overall trend of how the secondary characteristics vary with the maturity level of project definition deliverables was provided above. This section explores those trends in more detail. Typically, there are commonalties in the secondary characteristics between one estimate and the next, but in any given situation there may be wide variations in usage, methodology, accuracy, and effort.

The maturity level of project definition deliverables is the driver of the other characteristics. Typically, all of the secondary characteristics have the maturity level of project definition as a primary determinant. While the other characteristics are important to categorization, they lack complete consensus. For example, one estimator's bid might be another's budget. Characteristics such as accuracy is driven my many project risks and methodology can vary markedly from one industry to another, and even from estimator to estimator within a given industry.

6.1. Maturity Level of Project Definition Deliverables

Each project (or industry grouping) will have a typical set of deliverables that are used to support a given class of estimate. The availability of these deliverables is correlated to the maturity level or percent of project definition achieved, but maturity level does not express required quality or sequence information. The variations in the deliverables required for an estimate in specific industries are too broad to cover in detail here; however, it is important to understand what drives the variations. Each industry group tends to focus on a defining project element that drives the estimate maturity level. For instance, chemical industry projects are process equipment-centric—i.e., the maturity level of project definition and subsequent estimate maturity level is significantly determined by how well the equipment and process flow is defined. Architectural projects tend to be structure-centric, software projects tend to be function-centric, and so on. Understanding these drivers puts the differences that may appear in the more detailed industry addenda into perspective.

6.2. End Usage

While there are common end usages of an estimate among different stakeholders, usage is often relative to the stakeholder's identity. For instance, an owner company may use a given class of estimate to support project funding, while a contractor may use the same class of estimate to support a contract bid or tender. It is not at all uncommon to find stakeholders categorizing their estimates by usage-related headings such as budget, study, or bid. Depending on the stakeholder's perspective and needs, it is important to understand that these may actually be all the same class of estimate (based on the primary characteristic of maturity level of project definition achieved).

6.3. Estimating Methodology

As stated previously, estimating methodologies fall into two broad categories: stochastic and deterministic. These broad categories encompass scores of individual methodologies. Stochastic methods often involve simple or complex modeling based on inferred or statistical relationships between costs and programmatic and/or technical parameters. Deterministic methods tend to be straightforward counts or measures of units of items multiplied by known unit costs or factors. It is important to realize that any combination of methods may be found in any given class of estimate. For example, if a stochastic method is known to be suitably accurate, it may be used in place of a deterministic method even when there is sufficient input information based on the maturity level of project definition deliverables to support a deterministic method. This may be due to the lower level of effort required to prepare an estimate using stochastic methods.

6.4. Expected Accuracy Range

The accuracy range of an estimate is dependent upon risk. A number of characteristics of the estimate input information and the estimating process are systemic risks. The extent and the maturity of the input information is a highly important determinant of accuracy. However, there are systemic risk factors besides the available input information that also greatly affect estimate accuracy measures. Primary among these are the state of technology in the project and the quality of reference cost estimating data.

State of technology—technology varies considerably between industries, and thus affects estimate accuracy. The state of technology used here refers primarily to the programmatic or technical uniqueness and complexity of the project. Procedurally, having full extent and maturity in the estimate basis deliverables is deceptive if the deliverables are based upon assumptions regarding uncertain technology. For a first-of-a-kind project there is a lower level of confidence that the execution of the project will be successful (all else being equal). There is generally a higher confidence for projects that repeat past practices. Projects for which research and development are still under way at the time that the estimate is prepared are particularly subject to low accuracy expectations. The state of technology may have a significant impact on the accuracy range.

Quality of reference cost estimating data—accuracy is also dependent on the quality of reference cost data and history. It is possible to have a project with common practice in technology, but with little cost history available concerning projects using that technology. In addition, the estimating process typically employs a number of factors to adjust for market conditions, project location, environmental considerations, and other estimate-specific conditions that are often uncertain and difficult to assess. The accuracy of the estimate will be better when verified empirical data and statistics are employed as a basis for the estimating process, rather than assumptions.

In summary, estimate accuracy will generally be correlated with estimate classification (and therefore the maturity level of project definition), all else being equal. However, specific accuracy ranges will typically vary by industry. Also, the accuracy of any given estimate is not fixed or determined by its classification category. Significant variations in accuracy from estimate to estimate are possible if any of the systemic determinants of accuracy, such as technology, quality of reference cost data, quality of the estimating process, and skill and knowledge of the estimator vary. Finally, project-specific risks (e.g., risk events) also affect accuracy. Accuracy is also not necessarily determined by the methodology used or the effort expended. Estimate accuracy must be evaluated on an estimate-by-estimate basis in conjunction with some form of risk analysis process.

6.5. Effort to Prepare Estimate

The effort to prepare an estimate is usually determined by the extent of the input information available. The effort will normally increase as the number and complexity of the project definition deliverables that are produced and assessed increase. However, with an efficient estimating methodology on repetitive projects, this relationship may be less defined. For instance, there are combination design/estimating tools in the process industries that can often automate much of the design and estimating process. These tools can often generate Class 3 deliverables and estimates from the most basic input parameters for repetitive-type projects. There may be similar tools in other industry groupings.

It also should be noted that the estimate preparation costs as a percentage of total project costs will vary inversely with project size in a nonlinear fashion. For a given class of estimate, the preparation cost percentage will decrease as the total project costs increase. Also, at each class of estimate, the preparation costs in different industries will vary markedly. Metrics of estimate preparation costs normally exclude the effort to prepare the defining project deliverables.

7. ESTIMATE CLASSIFICATION MATRIX

The five estimate classes are presented in Table 1 in relationship to the identified characteristics. The maturity level of project definition deliverables determines the estimate class. For this RP, Table 1 provides generally indicative percent completions, but in industry-specific addenda RPs, design deliverable versus status matrix tables

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will be included which are the determinate of class. The other four characteristics are secondary characteristics that are generally correlated with the maturity level of project definition deliverables, as discussed above.

8. BASIS OF ESTIMATE DOCUMENTATION

The basis of estimate (BOE) typically accompanies the cost estimate. The basis of estimate is a document that describes how an estimate is prepared and defines the information used in support of development. A basis document commonly includes, but is not limited to, a description of the scope included, methodologies used, references and defining deliverables used, assumptions and exclusions made, clarifications, adjustments, and some indication of the level of uncertainty.

The BOE is, in some ways, just as important as the estimate since it documents the scope and assumptions; and provides a level of confidence to the estimate. The estimate is incomplete without a well-documented basis of estimate. See AACE Recommended Practice 34R-05 *Basis of Estimate* for more information [4].

9. PROJECT DEFINITION RATING SYSTEM

An additional step in documenting the maturity level of project definition is to develop a project definition rating system. This is another tool for measuring the completeness of project scope definition. Such a system typically provides a checklist of scope definition elements and a scoring rubric to measure maturity or completeness for each element. A better project definition rating score is typically associated with a better probability of achieving project success.

Such a tool should be used in conjunction with the AACE estimate classification system; it does not replace estimate classification. A key difference is that a project definition rating measures overall maturity across a broad set of project definition elements, but it usually does not ensure completeness of the key project definition deliverables required to meet a specific class of estimate. For example, a good project definition rating may sometimes be achieved by progressing on additional project definition deliverables, but without achieving signoff or completion of a key deliverable.

AACE estimate classification is based on ensuring that key project deliverables have been completed or met the required level of maturity. If a key deliverable that is indicated as needing to be complete for Class 3 (as an example) has not actually been completed, then the estimate cannot be regarded as Class 3 regardless of the maturity or progress on other project definition elements.

An example of a project definition rating system is the *Project Definition Rating Index* developed by the Construction Industry Institute. It has developed several indices for specific industries, such as IR113-2 [7] for the process industry and IR115-2 [8] for the building industry. Similar systems have been developed by the US Department of Energy [9].

10. CLASSIFICATION FOR LONG-TERM PLANNING AND ASSET LIFE CYCLE COST ESTIMATES

As stated in the Purpose section, classification maps the phases and stages of project cost estimating. Typically, in a phase-gate project system, scope definition and capital cost estimating activities flow from framing a business opportunity through to a capital investment decision and eventual project completion in a more-or-less steady, short-term (e.g., several years) project life-cycle process.

Cost estimates are also prepared to support long-range (e.g., perhaps several decades) capital budgeting and/or asset life cycle planning. Asset life cycle estimates are also prepared to support net present value (e.g., estimates for initial capital project, sustaining capital, and decommissioning projects), value engineering and other cost or economic studies. These estimates are necessary to address sustainability as well. Typically, these long-range estimates are based on minimal scope definition as defined for *Class 5*. However, these asset life cycle "conceptual" estimates are prepared so far in advance that it is virtually assured that the scope will change from even the minimal level of definition assumed at the time of the estimate. Therefore, the expected estimate accuracy values reported in Table 1 (percent that actual cost will be over or under the estimate including contingency) are not meaningful because the Table 1 accuracy values explicitly *exclude scope change*. For long-term estimates, one of the following two classification approaches is recommended:

- If the long-range estimate is to be updated or maintained periodically in a controlled, documented life cycle process that addresses scope and technology changes in estimates over time (e.g., nuclear or other licensing may require that future decommissioning estimates be periodically updated), the estimate is rated as *Class 5* and the Table 1 accuracy ranges are assumed to apply for the specific scope included in the estimate at the time of estimate preparation. Scope changes are explicitly excluded from the accuracy range.

- If the long-range estimate is performed as part of a process or analysis where scope and technology change is not expected to be addressed in routine estimate updates over time, the estimate is rated as *Unclassified* or as *Class 10* (if a class designation is required to meet organizational procedures), and the Table 1 accuracy ranges cannot be assumed to apply. The term *Class 10* is specifically used to distinguish these long-range estimates from the relatively short time-frame *Class 5* through *Class 1* capital cost estimates identified in Table 1 and this RP; and to indicate the order-of-magnitude difference in potential expected estimate accuracy due to the infrequent updates for scope and technology. Unclassified (or Class 10) estimates are not associated with indicated expected accuracy ranges.

In all cases, a *Basis of Estimate* should be documented so that the estimate is clearly understood by those reviewing and/or relying on them later. Also, the estimating methods and other characteristics of Class 5 estimates generally apply. In other words, an *Unclassified* or *Class 10* designation must not be used as an excuse for unprofessional estimating practice.

REFERENCES

1. Stephenson, H. Lance, CCP, Editor, *Total Cost Management Framework: An Integrated Approach to Portfolio, Program and Project Management*, AACE International, Morgantown, WV (latest revision).
2. AACE International, Recommended Practice 10S-90, *Cost Engineering Terminology*, AACE International, Morgantown, WV, (latest revision).
3. AACE International, Recommended Practice 42R-08, *Risk Analysis and Contingency Determination Using Parametric Estimating*, AACE International, Morgantown, WV, (latest revision).
4. AACE International, Recommended Practice 34R-05, *Basis of Estimate*, AACE International, Morgantown, WV (latest revision).
5. AACE International, Professional Guidance Document PGD 01, *Guide to Cost Estimate Classification*, AACE International, Morgantown, WV (latest revision).
6. AACE International Recommended Practice No. 104R-19, *Understanding Estimate Accuracy*, AACE International, Morgantown, WV (latest revision).
7. Construction Industry Institute (CII), PDRI: Project Definition Rating Index – Building Projects, Version 3.2 (115-2), Austin, TX, December 1, 2009.
8. Construction Industry Institute (CII), PDRI: Project Definition Rating Index – Industrial Projects, Version 3.2 (113-2), Austin, TX, December 1, 2009.
9. U.S. Department of Energy (DOE), *Project Definition Rating Index Guide for Traditional Nuclear and Non-Nuclear Construction Projects*, DOE G 413.3-12, July 22, 2010.

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