

The Estimate Review and Validation Process

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Abstract

This article focuses on the application of a fit-for-use methodology to the process of performing estimate review and validation and covers the contractor's and owner's points of view. The major steps of the estimate review and estimate validation cycle are examined. How good is your estimate? These are the first words that we, as estimators, normally hear upon presenting our estimates to our management or to our customers; and they are the same words we ask when first receiving an estimate prepared by others. We, of course, would like to think that any estimate we prepare is of high quality (although not necessarily highly accurate), but how can we be sure that this is the case? This article will focus on a methodology for the process of reviewing and validating capital cost estimates – either those we prepare ourselves or those prepared by others. The major steps of the estimate review and validation process will be examined, and we will discuss the realistic goals of an estimate review process.

Key words: Cost, estimating, deliverables, planning, review, risk, and validation.

Cost Engineering

The cost estimate is of paramount importance to the success of a project. The capital cost of a proposed project is one of the key determinants in evaluating the financial viability and business case of the new investment. From the owner's perspective, if the cost estimate is not accurate, the financial return from the capital investment may not be realized; and compounding this problem is the fact that other deserving projects may not have been funded. It is obvious that estimating is critical for the economic and optimal use of an owner's limited capital budget. From the contractor's perspec-

tive, accurate estimating is just as important. In a lump-sum bidding situation, the profit margin of the contractor is dependent on the accuracy of his or her estimate. If the project is exceptionally large, the loss from an inaccurate estimate on a lump-sum bid can potentially put a contractor out of business. For cost-plus projects, the contractor will face less direct economic risk from an inaccurate estimate, but the damage to the contractor's reputation can be severe. The cost estimate, however, serves other purposes besides establishing the budget for a project. It also serves as a tool or resource used for both scheduling and cost control of projects. The estimate not only establishes a project budget, but plays an equally important role in monitoring the budget during project execution. It is the relationship between estimating, scheduling, and cost control, which is typically identified by the term *cost engineering*, that serves as a driver for successful and cost-effective projects. Thus, an effective estimate must not only establish a realistic budget, but must also provide accurate information to allow for scheduling, cost monitoring, and progress measurement of a project during execution. Since we have established that an estimate is of critical importance to a project's success, it makes sense that the estimate should undergo a rigorous review process. The estimate should be evaluated not only for its quality or accuracy, but also to ensure that it contains all of the required information and is presented in a way that is understandable to all project team members and client personnel. A structured estimate review process should be a standard practice for all estimating departments. The following sequence of steps will discuss a formal review process for an internally prepared appropriation grade estimate, which is an estimate submitted for capital budget authorization. The level of detail and diligence used during the estimate review cycle will vary both with the strategic importance, total value, and purpose of the particular estimate. These steps can be easily adapted on a fit-for-use basis. Note that this article is focused on reviewing and validating an estimate – it does not discuss bidding strategies, which can involve many other factors and decisions.

Estimate Review Cycles

The principal purpose of an estimate review process is to present information about both the estimate and the project in a way that allows the reviewer to evaluate that the estimate is of sufficient quality to meet its intended purpose. The estimate review process is usu-

ally comprised of a series of estimate reviews, beginning with internal estimating department reviews, engineering reviews, project team reviews, and continuing with reviews by various levels of management, depending on the importance of the project.

Estimating Team/Estimating Department Review

The first review of the estimate should, of course, be conducted by the estimating team that prepared the capital cost estimate. This is essentially a screening review to ensure that the math is correct (i.e., extensions of pricing are correct, summaries add up properly, etc.), that the estimate is documented correctly and includes a comprehensive basis of estimate document, and that it adheres to estimating department guidelines. Typically, the lead estimator conducts this review with the members of his or her estimating team. On very large projects or those of significant importance, this review may be conducted by the estimating department manager or supervisor.

Check the Math

The first step of the review is to ensure that all of the math used in the estimate is correct. With today's computerized estimating systems, this is much less of a concern than 20 years ago when estimates were primarily prepared by hand using simple calculators. However, math errors can still occur. This can be a major concern when using an electronic spreadsheet, such as Excel, for preparing the estimate. Surprisingly, it is very easy to make a formula error in a spreadsheet, such as inserting a row or column that does not get included in a subtotal. All spreadsheet formulas, subtotals, and totals should be examined carefully for correctness. From a client's point of view, nothing will help to lose credibility in the entire estimate faster than a finding a math error that went undetected.

Basis of Estimate

The comprehensive *basis of estimate* (BOE) document should be reviewed carefully to ensure that it is both correct and complete. The BOE is an extremely important document. The dollar amount indicated on an estimate is meaningless without knowing the parameters, or what is included and not included in the estimate. The BOE

serves to clearly define the design basis, planning basis, cost basis, and risk basis of the estimate.

- *Design Basis:* The overall scope of the project should be summarized, with additional detail provided for each area/unit/work package of the project. Specific inclusions, and even more importantly, specific exclusions of items or facilities, should be documented. All assumptions regarding project scope should be documented. If available, equipment lists should be attached or referenced, and a listing of all drawings, sketches, and specifications used in the preparation of the estimate should be documented, including drawing revision date and number.
- *Planning Basis:* This portion of the BOE should document important information from the *integrated project plan* that affects the estimate. It should include specific information about any contracting strategies for engineering, design, procurement, fabrication, and construction. It should include information about resourcing and project execution plans such as the length of the workweek, use of overtime, number of shifts, etc. It should also include information about the project schedule and key milestone dates affecting the estimate.
- *Cost Basis:* The source of all pricing used in the estimate should be documented in this section of the BOE. This would include the source of all bulk material pricing, the pricing of major equipment (referencing quotes or purchase orders if used), and all labor rates including office, engineering, fabrication, and construction. The source of all labor workhours should be documented, along with any assumptions regarding labor productivities. All allowances included in the estimate should also be clearly identified. It is also important to document the time basis of the estimate, and the basis for cost escalation included in the estimate.
- *Risk Basis:* Since, by definition, every estimate is a prediction of probable costs, it is clear that every estimate involves uncertainty and risk. Contingency is typically included in an estimate to cover the costs associated with this uncertainty. This section of the BOE should document how the contingency was determined, and identify key areas of risk and opportunity in the cost estimate. It is important to ensure that the *basis of estimate* is clear and easily understood, and to verify that all information and factors documented in the BOE have been consistently applied throughout the estimate, including such items as wage rates, labor productivities, material and subcontract pricing, etc. Again, the estimate can lose credibility if different pricing

or labor rates have been used for the same item within the estimate detail.

Estimating Department Guidelines

A careful review should be done to verify that the cost estimate follows standard estimating guidelines for the department. This would include a review to verify that standard estimating procedures were followed regarding estimate format, cost coding, presentation and documentation. This would include items such as the following.

- Verify that the proper estimating methods, techniques and procedures were used that match the stage of project completeness. In other words, different estimating techniques will be used depending on the type and completeness of the engineering documents and deliverables available to create the estimate. Confirm that the estimate summary and details are organized and presented in the proper format. The estimate should follow the project work breakdown structure and code of accounts. Also, the estimate format needs to be consistent with the intended purpose of the estimate, and provide sufficient detail to meet this purpose.
- Ensure that all estimate backup information is organized properly. Can all values on the summary page of the estimate be traced to the estimate detail pages, and can all information on the estimate detail pages be traced to the estimate backup or source documents?
- Verify that all allowances and factors are appropriate for the type of estimate being prepared, and are consistent with comparable projects and estimates. This level of estimate review helps to ensure that all estimates prepared by the department are using established guidelines, and are presented in a consistent manner from project to project.

Engineering/Design Review

The next level of estimate review should be held with the engineering team, and should evaluate the estimate in terms of accurately representing the project scope. The core members of the engineering team are key participants in this review, along with the lead estimator and estimating team.

Completeness of Engineering Deliverables

One of the first items to review is the listing of all drawings, sketches, specifications, and other engineering deliverables used in preparing the estimate to ensure that it is complete (see design basis above). The lead engineers need to cross-reference this listing against their own engineering drawing and deliverables lists to make sure that all relevant information was passed on to the estimating team. The revision numbers of drawings should be checked to ensure that they match the intended revision for the estimate. If late changes to the engineering drawings have occurred, and are intended to be incorporated into the estimate, this needs to be checked to ensure that all late changes have been included.

Equipment List

The equipment list and equipment pricing should be double-checked by the engineering team for completeness and accuracy. Equipment is often one of the key drivers of cost and scope, and needs to be checked carefully for completeness and accuracy.

Design Basis of Estimate

The engineers should review the *basis of estimate* and summary of project scope carefully to verify and correlate their understanding of the project scope with that expressed in the estimate. All exclusions expressed in the BOE should be agreed to; and all allowances and assumptions verified. If there have been any questions about interpretation of the drawings or engineering deliverables, now is the time to discuss the estimator's interpretation with the engineers, and to make sure that the project scope is accurately reflected in the estimate. All drawings used for the estimate should be available during this review. Sometimes it can help to have the estimator explain how each drawing was used in the preparation of the estimate. For example, the estimator may describe whether particular quantities were obtained from a detailed takeoff using isometric drawings, or if the quantities were derived from a P&ID and plot plan.

Engineering/Design Costs

The engineering team should also review the assumptions and costs associated with the engineering and design portion of the estimate. The engineering team needs to feel comfortable that the amount of money included in the estimate for engineering, design, and support is adequate for the level of effort expected to be expended on the project.

Risk Basis of Estimate

Last, the engineering team should review the risk basis of the estimate, and be in position to agree with the analysis of cost risk associated with the estimate. The level of risk associated with scope definition, and with engineering/design costs should be of particular interest to the engineering team, and concurrence sought. As mentioned, the goal of this portion of the estimate review is to make sure that the scope of the project as understood by engineering is reflected in the estimate. At the end of the engineering review, the estimate should have the full support of the engineering team during subsequent reviews.

Project Manager/Project Team Review

Once the estimating and engineering teams have reviewed the estimate closely, it is ready for review by the project manager and the rest of the project team. The objective now is to gain the entire project team's support of the estimate, and especially that of the project manager. This is also the first point where the estimate should be able to pass overall validation tests, in addition to a quality review.

Estimate Documentation

The first part of this review should be the examination of the estimate documentation by the project team and project manager. This includes the basis of estimate, as well as the estimate summary and estimate detail pages. The purpose is to ensure that the estimate is presented in an understandable manner. If standard estimating guidelines have been followed (as discussed above), all estimates

should be presented in a consistent and understandable style. It is very important that the project manager fully understand how the estimate is prepared because he/she often becomes the person responsible for presenting, and sometimes defending, the estimate to upper management, and later to the eventual customer. The entire project team should also understand the entire estimate package, format and contents.

Cost Review

Engineering should have already reviewed the engineering, design, and associated support costs. Now is the time for the other key members of the project team (project manager, project controls, procurement, construction manager, commissioning manager, etc.) to examine their respective costs that are included in the estimate, and to obtain agreement that they are correct. Although primarily the responsibility of the estimating team, the scope related costs should also be reviewed by the rest of the project team to gain consensus. In particular, the following areas should be discussed:

- Verify that the latest project schedule agrees with the estimate, particularly as it relates to escalation.
- Examine the project administration, and other home office related costs for reasonableness.
- Conduct a final constructability review to ensure that the methods of installation and construction assumed in the estimate are reasonable and cost effective.
- Review the construction indirect costs (field staff, temporary facilities, temporary services, construction equipment and services, construction tools and consumables, etc.) to make sure they are reasonable.
- Ensure that all required start-up and commissioning materials are included, if required. This is often an area of cost that is overlooked.
- For international projects, there may be many more items of cost that should be carefully reviewed. These may include such items as international labor adjustments for productivities and wage rates, adjustments for workweek variations, material cost adjustments for both local and globally sourced materials, international freight costs, international duties and taxes, labor camp costs, premiums for expatriate costs, etc.

Estimate Validation

In most organizations, the project manager is ultimately held responsible for the execution of the project. Therefore, the project manager has a vested interest in performing „sanity checks” or otherwise validating the estimate as reasonable. Most experienced project managers will have various „rules-of-thumb” that they will want to use to verify against the estimate. Regardless, the estimate should include an estimate review metrics report that summarizes and compares several key benchmark ratios and factors versus historical values from similar projects. If sufficient historical data from completed projects is not available, information from other trusted estimates may need to be substituted. The goal is to ensure that key metrics from the estimate are in line with the same metrics from similar projects. If there is a large discrepancy, it must be explainable by the particular circumstances of the estimated project versus the similar completed projects. Such comparison metrics may include values such as percent of administration (home office) costs, percent of engineering/design costs, equipment to total field cost ratios, equipment to total project cost ratios, cost per piece of equipment, labor hours per piece of equipment, and cost to plant capacity ratios (\$/BBL, \$/SF). Sometimes the metrics will be generated down to the discipline level where you may look at ratios such as cost per diameter inch of piping, cost per cubic yard of concrete, and cost per ton of steel. In addition to examining key benchmark metrics and ratios, another form of estimate validation may involve preparing a quick check estimate using order of magnitude estimating methods. Again, any large discrepancies between the estimates should be able to be explained by the peculiarities of the project. Estimate validation is a very important activity during the project review cycle, and the proper tools need to be in place to allow this to occur. Benchmarking key estimate ratios and metrics depends upon having a project history database in place to collect, analyse and present the required information. Similarly, the capability to provide quick check estimates depends on having the correct strategic and conceptual estimating information and tools ready for use.

Risk Basis of Estimate

The project manager and project team should again review the risk basis of the estimate, and agree with the analysis of cost risk associated with the project. The project manager, in particular, should

agree with the risk assessment and contingency amounts, and be able to defend it in subsequent review to upper or corporate management.

Reconciliation to Past Estimates

Last, the project manager will usually be interested in reconciliation of the current estimate to the preceding estimate or estimates. This is an important, but often overlooked, aspect to the overall estimate review process. The current estimate can gain credibility by comparing it with earlier estimates, and clearly explaining the differences and reasons for the differences. The reconciliation can usually be presented at a high level, without excessive detail, but the backup should be available in case it is required during the review.

Management Reviews

The last series of reviews is usually held by various levels of corporate management. The number of upper management reviews, and the level of management they are presented to, typically varies with the strategic importance and/or total estimated cost of the particular project. These reviews are typically conducted at a very high level of analysis, and usually do not involve the details of the estimate. Upper management reviews often focus on substantiating the overall adequacy of the estimate in regards to its intended use. In other words, can management be assured that the level of detail available for the estimate, the estimating methods employed, and the skills of the estimating and project teams support their decisionmaking process on whether to proceed? As with the project manager review, estimate validation is a key element of the upper management reviews. It is important to be able to explain and demonstrate that metrics for the current estimate are in line with data from other similar projects – i.e., that the estimate is reasonable. It is also important to show where the metrics may be substantially different from other projects, and provide explanations for the differences. Management will also be interested in the cost risk assessment. It is important to clearly and concisely explain how the contingency amount was developed, and what the levels of risk are. It is then up to management to accept the level of risk indicated, or change the amount of contingency and accept more or less risk for the project. When reviewing the risk analysis, it is always important to discuss the areas of high risk, and what is being done to mitigate those risks.

Up until the management reviews, the estimate review will have typically concentrated on the project as defined by the project scope documents. If the project were to be built according to any other defined alternatives, what would they cost? Usually, the recommended alternative for project scope has long since been determined and agreed to by the project team, and the engineering deliverables created for preparing the estimate have been focused on a single design alternative. However, many times management will start asking questions concerning other alternative scopes or designs. One of the certainties is that management will always think the project cost is too high, and will now be probing to determine if there are lower cost options. Therefore, it is important to have available for the management reviews any earlier design/cost alternatives, and the decision tree leading to the selected design. The effectiveness of an estimate review relies on the information that is presented, and the manner in which it is presented. The above discussion has concentrated on how to structure a sequence of estimate reviews for internally prepared estimates to ensure that estimates are well documented, consistent, reliable, and appropriate for their intended use. After this review cycle, the level of estimate accuracy should be apparent, reflective of the scope information available for preparing the estimate, and capable of supporting the required decision making process for the project. Next, we will discuss techniques for reviewing estimates prepared by others.

Reviewing Estimates Prepared By Others

The foregoing discussion has focused on structuring an estimate review process for the estimates that we internally prepare to ensure that the estimate is of a high quality and supports the decision making process of our management. Often, we may also find ourselves in a position to review and/or approve estimates prepared by others, and that may or may not have gone through a rigorous internal review cycle as described above. When reviewing estimates by others, we always want to keep in mind the basic fundamentals previously described. Complicating the matter, however, is the problem that many times the amount of time allowed for a complete estimate review is very short. Thus, the review of an estimate prepared by others is usually accomplished by a critical assessment of the estimate and its documentation, and a series of questions to assist in evaluating the level of diligence used in preparing the estimate. The

following discussion centers on guidelines that we can use to efficiently review estimates prepared by others.

Basis of Estimate

The first thing to assess is the *basis of estimate*. Is it well organized and complete? Does it provide the required information regarding the design basis, planning basis, cost basis, and risk basis of the estimate? Does the design basis clearly document the scope of the project, and have all engineering deliverables used in developing the estimate been identified? Have all scope assumptions been acknowledged? Is the planning basis, which includes the schedule, resource plan, and construction plan, reasonable? Are the material prices, labor rates, and labor productivities reasonable, in line with expectations, and consistently applied throughout the estimate? Has the risk basis been clearly defined, and is it reasonable for the level of information available to prepare the estimate?

Estimating Personnel Used

Next, you will want to know who prepared the estimate, and their level of estimating experience. Do they have established estimating procedures and guidelines? Was the estimate checked and reviewed before publication?

Estimating Methodology and Procedures

What estimating methods, techniques and procedures were used in preparing the estimate? Are they appropriate for the level of information available and project type? Were different estimating methods used for different parts of the estimate? Is the level of detail in the estimate sufficient for the purpose of the estimate? Were parts of the project difficult to estimate, and why? Was sufficient time available to prepare the estimate? What adjustments were made to the estimate for location, complexity, etc., and are they reasonable? Was the estimate prepared using a code of account structure?

Estimate Documentation

Is the estimate documented clearly? Is the estimate summary and detail pages well organized, and presented at an appropriate level of

detail? Is every cost appearing on the estimate summary traceable to the estimate detail and other estimate backup?

Estimate Validation

Hopefully, the estimate for review will include a metrics report showing key estimating metrics and benchmark ratios for the estimate and similar past projects. You should review this report, and question any significant differences. You should also have your own set of metrics and statistics from your own project history to compare against. At this point, you may also develop your own quick check estimate for comparison purposes, typically using conceptual estimating techniques. This is always a good practice to see if the estimate being reviewed is reasonable. If there is a significant difference, then question the estimator and listen to his or her explanations and opinions for the deltas. Significant differences between the check estimate and the estimate being reviewed may indicate the need for taking a more thorough examination of the estimate detail.

Estimate Detail

If the preceding inquiry, or should we say interrogation, has gone well, and you are confident that the estimate appears to have been prepared in a professional manner, you are ready to delve into some of the estimate details to verify estimate quality. The goal is to check that selected areas of the estimate can withstand further scrutiny. The key here is to not get too deep into the details, and lose sight of the forest for the trees. An important point to remember here is the „80/20 rule“. This principle generalizes that 80 percent of the cost will come from 20 percent of the estimate line items. For any particular estimate, the significant cost drivers may vary. Sometimes, the main cost driver may be a particular process unit of the project; other times it may be the type of process equipment or machinery throughout the project, and still other times it may be the overall bulk material quantities or labor manhours. You should examine the estimate summary and detail pages closely to ascertain which aspects of the estimate you may want to examine in closer detail. Basically, you should examine in detail those items of the estimate that will have the most significant cost effect if estimated incorrectly. One review technique, which is often employed, is to thoroughly examine and review the estimating steps that were used for

G1041-14 The Estimate Review and Validation Process

a particular part of the estimate. Select an area of the estimate, and ask how the quantities were derived. Don't just take their word for it, however. Ask the estimators to show you the drawings from which the quantities were generated. Perform a quick takeoff to see if the quantities can be verified. Ask what the basis was for the unit material price and labor workhours. Have these been consistent throughout the estimate? What adjustments were made and why? If the answers to your questions are evasive, it may call into question the credibility of the entire estimate, and a more thorough review of the complete estimate may be necessary. If your questions are answered confidently, and the answers can be verified against the engineering deliverables and scope information, then you may decide to check the rest of the estimate details in a more cursory fashion. Typically in this situation, once you have shown the wherewithal to compel the estimator to back up any claims or explanations, he/she will discover they can't just, „pull the wool over your eyes.” From that point forward, you will usually find that you are getting honest answers to your questions.

The goal of an estimate is to predict the probable cost of a project. The goal of an estimate review is to determine that a high quality and sufficiently accurate estimate has been prepared. The review should ensure that the proper estimating methods, procedures, techniques, data, and guidelines have been employed in the preparation of the estimate. The use of a structured estimate review process and estimating review techniques will help to ensure that quality estimates are consistently prepared which effectively support the decision-making process by management.