AECOM

Construction Cost Assessment

Preliminary Report

State of Washington, Office of Financial Management

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Delivering a better world

Prepared for:

State of Washington, Office of Financial Management

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Goal of the study

The goal of the construction cost assessment is to provide recommendations to ensure cost estimates accurately reflect project costs for both standard and alternative public works projects. The study is required by Washington State's 2021-23 Capital Budget (Sec. 1099, Chapter 223, Laws of 2021). It will ultimately result in recommendations, and updated draft files to include an Excel project cost estimator, architectural and engineering fee guidelines and an architectural and engineering fee schedule

This includes identifying how best to set capital budgets for projects while meeting the following criteria:

1. **Value for money**: The project must meet the defined objectives for the facility at a cost that is fair and reasonable, both for hard (construction) cost and soft (owner costs/fees/services) cost. "Fair and reasonable" means that the state pays an appropriate price to deliver the mission of the building, one that is in line with comparable facilities.

2. **Cost confidence**: The budget must be sufficient that the projects can be completed as proposed within the available funds and address reasonably foreseeable risks without requiring additional funding.

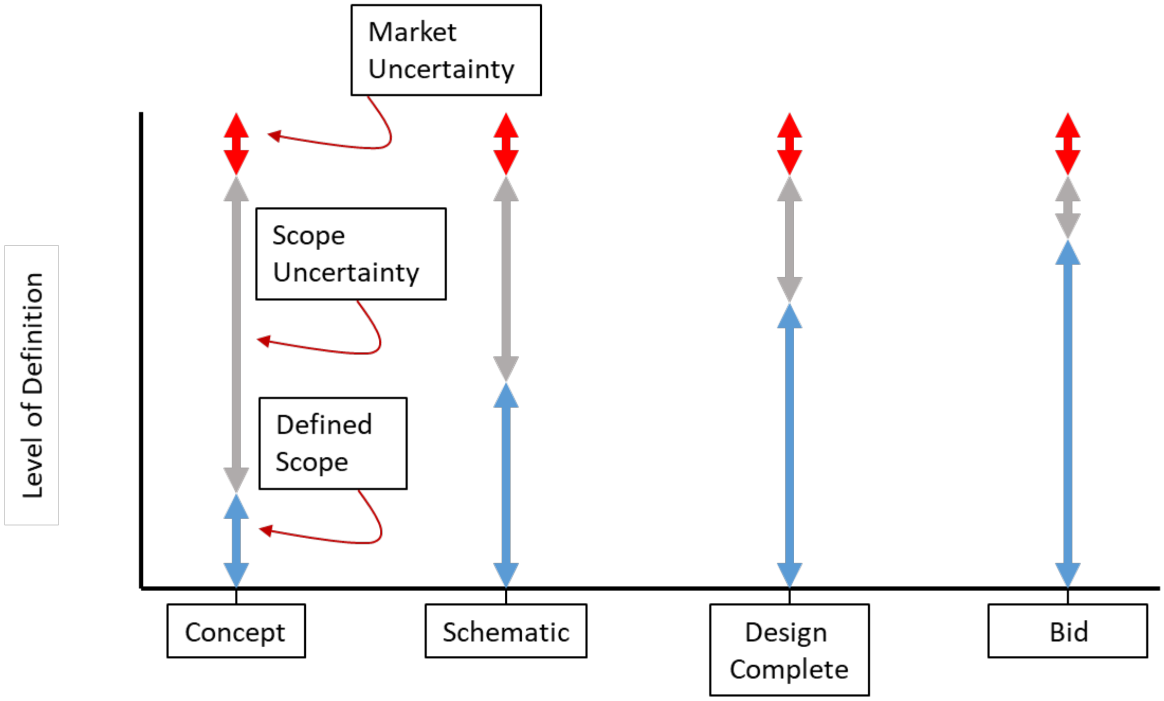
3. **Cost control**: Any contingencies or allowances for risk must be minimized, clearly identified, and managed to avoid inappropriate expenditure or inefficient use of funds.

4. **Cost effective**: The process must be cost effective, and achievable within the resources of the proposing agency and the Office of Financial Management.

The budget estimates must meet these objectives even though estimates are typically generated 2 – 3 years before construction starts (often as early as five years before a project is completed) and are generated well before design starts. This means the estimating practices must be sophisticated enough to work with high levels of uncertainty – both the scope and design uncertainty that will be addressed by the agency and project team through design, and the escalation and market risk, as we show in the figure below.

This preliminary report is focused on findings for industry best practices for cost estimating for public works projects, with particular attention on construction cost escalation and options for escalation calculations. Detailed recommendations related to formulas and practices for state agency capital project cost estimating (C-100 form) to ensure cost estimates accurately reflect project costs for standard and alternative public works project delivery, and recommendations for construction cost escalation, project management fees, consultant extra services, and project contingences will be addressed in the final report.

Figure 1: Level of definition of design



Current state practices

Currently the state has access to, and applies, many of the best practices for budget estimating. While these best practices are not universally used across all projects and agencies, the capital planning process works effectively, and capital projects are successfully delivered across all agencies. If the state applied a more consistent application of these practices, it could further improve consistency and accountability.

The current practices at OFM for establishing and managing capital budgets are as follows:

1. Agencies/project sponsors submit a budget proposal to OFM through the Capital Budgeting System and include supporting cost information for construction projects over $5 million using the Excel C-100 form which was developed by OFM. The C-100 includes calculations for project contingency, engineering and architectural fees, agency project management fees, and escalation.

2. OFM reviews the budget proposal to make sure it is complete and generally “fair and reasonable” based on the agency C-100 entries. Individual agencies are responsible for ensuring that the estimates and supporting data are complete and correct. Agencies can take on pre-design, either from their own funding, or from a capital budget allocation, but it is not required for projects under $10 million.

3. OFM includes projects into the Governor’s proposed budget. Capital projects may be funded as total projects with one or more appropriations with funding for three main stages: pre-design, design and construction. The Legislature develops the final capital budget, including some projects from the Governor’s proposal and some new projects. The capital budget is enacted, and funding becomes available to state agencies once the budget is signed into law by the Governor.

4. When projects are funded, the capital appropriation is fixed, and any further additions need legislative action. For projects funded in stages, agencies may request adjustments to their budgets for future stages.

5. Capital funding is in the form of a “lump sum” for the project phases, and funds can be moved across project categories (from fees to construction, for example). Reallocations do not need to be approved, except where there is specific legislative language related to the funding. In practice, OFM has a degree of oversight and control through the allotments.

6. Once funded, the sponsor agency provides high-level reporting to OFM twice a year and at project close-out through the major project status report/final close-out report. (as required by RCW 43.88.160). Beyond the requirement for agencies to submit semi-annual major project reports, the state does not have procedures in place to systematically compare that capital facility budgets and scope are completed as approved by the Legislature.

7. Completion of a capital project could span over one to more biennia. Any unused funding is reauthorized or “reappropriated” to compete the project.

Life cycle costing is required for all capital project submissions using three specific excel tools.

- During pre-design, the project is required to use the Life Cycle Cost Model (LCCM) tool to evaluate design options.
- During the design stage, the project is required to use the Life Cycle Cost Tool (LCCT) to demonstrate how the building design contributes to energy efficiency and conservation. The LCCT is required for facilities with an area of 5,000 square feet or greater.
- In addition, there is the Energy Life Cycle Cost Analysis (ELCCA) maintained by the DES Energy Program

These are all sophisticated tools designed for evaluating design options

Gap assessment

The current practices are similar to practices at comparable state agencies in other states. While there are no significant gaps related to projects, there are, however, opportunities to add and enhance the practices to improve the overall workflow between state agencies, OFM, and the Legislature.

Consistency of Budget Submissions

Budget estimates are submitted by agencies with varying amounts of programming and preparation. In some cases, the agencies base their estimates on simple benchmark costs per square foot, with no refinement to address specific program needs. This can lead to a mismatch between available funds and the program’s need. Since budgets are fixed, balancing funds and needs leads to project scope changes. Typically, this is minor, but it could mean a project is significantly different from the proposed project. Even when an area or scope doesn’t change, the project quality could be modified and bring about poorer life cycle cost performance.

When a mismatch results in overfunding, there is a risk that a project gets enhanced in a way not intended within the original funding. That means agencies incorporate ‘lower value adds’ instead of returning funds to the state.

There are currently no constraints that require a resubmittal if the area or program is substantially changed. (For example, some states have a provision that the gross area cannot be changed more than 10% without resubmission).

The lack of consistency in budget quality and structure means funds might not deliver the intended project.

Data Management

Another concern related to budget submission consistency is the ability to manage and retrieve data across the portfolio of projects. The C-100 forms provide good data consistency and capture, but the forms are not currently stored in a data management system. This makes it difficult to retrieve valuable historic data to benchmark and compare.

Also, since there is no systematic capture of post-award and post-construction reporting of costs by agencies, there is no process to validate the C-100 data. If OFM captured the data from the project status and close out reports, the C-100 database could become an extremely valuable data repository, particularly as data builds over time.

Escalation and Location/Market adjustment

Construction cost escalation is a major concern across the country. Projects become underfunded when inflation and market adjustments are inadequate. As we noted above, agencies can often solve this by reducing a project's scope or quality.

Location adjustments are also important to ensure that the proposed funding is sufficient for the project location. This is particularly key for projects in the smaller construction markets in the state, where a small project may be within the market capacity, and so may cost less than a comparable project in a major urban area. In contrast, a large or complex project in small or rural markets may need resources from the wider region, and so be more expensive than a comparable urban area.

Contingency and Risk Management

There is currently no requirement for systematic risk assessment and management. This raises the risk that projects funds are mismatched with scope, which leads to reduced scope/quality or 'low value' adds to absorb excess contingency. Risk assessment is most effective when initiated early in a project, preferably starting in pre-design, and continued through the design and construction phases.

Value-engineering analysis and constructability reviews are required during the design phase of a project (RCW 43.88.110(5)(c)), and the work must be included in the project schedule submitted as part of the pre-design. While the timing is not specified in the requirement, these are often undertaken late in the design phase. These reviews can be an important part of the contingency and risk management process.

The best practices we suggest for OFM's consideration

1. Additional estimate submission requirements

Establish minimum requirements for program statements and estimates. For large projects, much of this will typically be included in a pre-design study. This recommendation is to expand the requirements to smaller projects and to establish a systematic and consistent submission framework for larger projects. The minimum requirements should include the following:

- Clear scope of work: Agencies should submit a qualitative and quantitative project description, including space programming, key functional elements, and performance standards. Room data sheets are desirable, but not necessary.
- Capital cost estimate to ASTM Uniformat Level 2 at a minimum, preferably Level 3. (See Appendix B for Uniformat Structure) Estimate should document all cost-influencing ground rules and assumptions. This includes:
    - Anticipated delivery/procurement methodology
    - Schedule
    - Site conditions, constraints
    - Operational considerations (occupied site, congestion, accelerated schedule, logistics challenges)
    - Anticipated architectural expression/materials/appearance
- Life Cycle Costing. Streamline the life cycle costing tools to a common platform and include an assessment of total cost of ownership as opposed to just comparison of alternative concepts. The life cycle cost tools should also be modified to make them suitable for evaluating non-building projects. As written, they are not easy to adapt to the full range of capital projects.

2. Escalation/market analysis

Establish a requirement for a high-level market evaluation to be provided by the project sponsors, to identify key market distorting factors: bidder capacity, supply constraints, etc. This should inform what escalation and location adjustments related to the local market capacity and skill base should be addressed in the budget and incorporated into the C-100.

3. Risk assessment

Establish a requirement for a concept-level risk assessment to be completed by the project sponsor which will, at a minimum, address the following:

- Identify significant risks (or opportunities) that impact the project.
- Characterize the risk by likelihood and consequences, duration, reducibility.
- Identify the risk management approach – elimination/reduction, mitigation, contingency.
- Document the action plan.

Some of the pre-design studies currently address risk. This recommendation is to formalize the process and to extend it to smaller projects. For smaller projects, the assessment can be easily addressed by the project team without the need for risk consultants.

4. Cost and program capture at construction award and completion

Establish procedures to capture the actual cost and program at the award stage and construction completion stage using the current Major Project Status Reports (MPSR) and close-out documentation. This provides valuable feedback on the quality of budget submittals. It will also indicate how projects perform, and where agencies are reallocating funds or adjusting scope/quality. Even if OFM does not use the feedback as an enforcement mechanism, the information will improve budgeting and scoping performance, by building a benchmarking database.

5. C-100 database

Create a database of C-100 submittals and MSPRs to support consistency and establish easy data retrieval for benchmarking and comparison.

Current industry best practices for estimating

Sources of best practices

There are several published sources for practices for estimating. These include:

- ASTM International (formerly known as American Society for Testing and Materials) standards
- Government l organizations such as the federal government Accountability Office (GAO), the U.S. Army Corps of Engineers (USACE) and the General Services Administration (GSA).
- Professional organizations such as AACEi (formerly known as Association for the Advancement of Cost Estimating, International) the American Society of Professional Estimators (ASPE) and the Royal Institution of Chartered Surveyors (RICS).

In addition, each state budget office has guidelines and policies. However, these are rarely organized into a single policy or practice manual. (We included a detailed list of the best practice sources in Appendix A).

Summary of best practices

While there are some differences in practices, there are some clearly identifiable common best practice principles across all practices. These are best stated in the U.S. GAO document Cost Estimating and Assessment Guide:

> GAO's research has found that a reliable cost estimate is one that is comprehensive, well documented, accurate, and credible. Management minimizes the risk of cost overruns and unmet performance targets by ensuring cost estimates reflect these four characteristics.
>
> **Comprehensive** cost estimates completely define the program and reflect the current schedule and technical baseline. They are structured with sufficient detail to ensure that cost elements are neither omitted nor double-counted. Where information is limited and judgments must be made, assumptions and exclusions on which the estimate is based are reasonable, clearly identified, explained, and documented.
>
> **Well-documented** cost estimates can easily be repeated or updated and can be traced to original sources through auditing. Thorough documentation explicitly identifies the primary methods, calculations, results, rationales or assumptions, and sources of the data used to generate each cost element's estimate.
>
> **Accurate** cost estimates are developed by estimating each cost element using the best methodology from the data collected. Accurate estimates are based on appropriate adjustments for inflation. Their underlying mathematical formulas, databases, and inputs are validated, and the resulting estimates contain few, if any, minor mathematical mistakes. Accurate estimates are based on a historical record of cost estimating and actual experiences from comparable programs. Finally, they are updated regularly to reflect significant changes in the program. Any variances between estimated and actual costs are documented, explained, and reviewed.
>
> **Credible** cost estimates discuss and document any limitations of the analysis, including uncertainty or bias surrounding source data and assumptions. The estimate's major assumptions are varied to determine how sensitive it is to changes. Credible cost estimates include a risk and uncertainty analysis that determines the level of confidence associated with the estimate. In addition, high-value cost elements are cross-checked with alternative estimating methodologies to validate results. Finally, the estimate is compared with an independent cost estimate conducted by a group outside the acquiring organization. (US Government Accountability Office, 2020)

In practice, these principles dictate that estimates — even at the preliminary budget stage — should contain the following elements:

- Clear scope of work
- Analytically prepared budget estimate
- Clearly stated estimate
- Life cycle cost evaluation

Clear scope of work

For a budget estimate to be reliable, it must be anchored in a defined scope of work that, at a minimum, establishes clear performance and key quantitative and qualitative expectations.

The scope of work defines the project's functional needs, interior and exterior functional requirements. This includes space sizes, contents, activities and relationships. It should also include:

- Statement of need
- Definition of the users and the purpose of the users
- Planned functions and programs
- Assigned square feet of the proposed facility
- Quality

The scope of work should include sufficient detail to help agencies identify key cost drivers. This does not require detailed design responses but does require a thoughtful assessment of a project’s needs and an understanding of the major cost drivers. Typically, this work will need engagement from the programming and budgeting team. The cost normally ranges between $100,000 to $250,000 per project. While this is not insignificant, it only represents a small percentage of the total project cost.

Example 1: Cost driver

Cost driver example:

For a laboratory building, fume hood density is a major cost driver for the mechanical system. Typically, at a program level, the actual fume hood demand is not known, but it can be broadly known from the program of requirements. organic chemistry spaces will usually demand higher fume hood density than that of physics spaces. Teaching laboratories will typically require more fume hoods than research facilities. By identifying space programs, the reliability of the cost estimate for the mechanical system will be significantly improved, as compared to generic cost per square foot.

The clear scope of work also provides a basis for the project’s development and how to evaluate the ultimate delivery to make sure the original project is delivered.

Analytically prepared budget estimate

The cost estimates should reference the clear scope of work in enough detail to help agencies generate accurate target quantities. Typically, these estimates will use parametric principles, where quantities come from the program statement and reference previous projects. It is possible to develop estimates from historic cost benchmarking as long as the benchmarks are relevant and directly comparable. Agencies can also use benchmarks to validate parametric level estimates. A third approach is to develop an engineering build-up estimate, which requires agencies to develop the design to a sufficient level that establishes a detailed cost model. This approach is appropriate for unique and unusual projects, or it may be used to supplement parametric or benchmark estimate and address special features.

Principles of parametric estimating

In the context of estimating, parameters are quantities for major building elements derived algorithmically from program requirements. The parameters broadly define a building's geometry and character. Examples of commonly used parameters are shown in *Table 1: Common Building Parameters.* Someone can quickly find these parameters from the program statement and by referencing comparable facilities. As we show in the parameter example below, exterior cladding quantities can easily be developed. Someone can also apply similar processes to develop the other parameters. For a one-story visitor center, for example, the roof is likely to be sloped with overhangs, which makes it slightly larger than the gross area. Partitions can be modeled based on the number of rooms, and so forth.

Table 1: Common Building Parameters

Areas	
Gross Area	gross square feet
Net Assignable Area	net assignable square feet
Building Elements	
Slab on Grade Area	square feet
Elevated Structure Area	square feet
Gross Wall Area	square feet
Retaining Wall Area	square feet
Finished Wall Area	square feet
Windows/Glazing Area	square feet
Roof Area	square feet
Interior Partition Length	lineal feet
Finished Area	square feet
Elevators	each
Plumbing Fixtures	each
Total Cooling Load	Tons
Electrical Load	kiloWatt
Site Elements	
Gross Site Area	square feet
Finished Site Area	square feet
Paved Area (roads and parking)	square feet

Someone can also test these against benchmarks for comparable projects, which would confirm that 0.700 – 0.900 square feet of wall to gross area ratio is reasonable for a visitors' center, and 0.30 – 0.50 is reasonable for a midrise office building.

Example 2: Parameter examples

Parameter examples

Visitor Center - Single story, 5,000 square feet, architecturally interesting

Envelope:

- Minimum perimeter would be a square building. 5,000 square feet would require a square of sides of approximately 70', for a total perimeter of 280'; for a rectangle 2:1, the sides would be 50' x 100', for a total perimeter of 300.' A reasonable perimeter is therefore in the range of 300'
- Allow a height to eaves of 12', gives a net exterior skin of 3,600 square feet.
- Allow for some articulation, say, 10% for a recommended skin area of 3,960 square feet, or 0.792 of gross floor area

Office building, midrise -250,000 square feet, commercial quality

Envelope

- Assume midrise is 5 story, so each floor plate is 50,000 square feet. The minimum perimeter as a square has sides of 223' for a perimeter of 900'. A rectangle of 2:1 would be 160' x 320, or 960' perimeter.
- At 2:1, the distance from the center to the window (lease depth) would be 80', which is fairly high for an office, so test 3:1 which gives a floor plate of 130' x 390', a perimeter of 1,040' and a lease depth of 65'. This can be validated with the program quality statement.
- Allow for a floor-to-floor height of 13', gives a net exterior skin of 13,520 square feet per floor, or 67,600 square feet in total.
- Allow for some articulation at 10% gives a skin of 74,360 square feet, or .297 of gross floor area.

One advantage of parameters is that they are far less time- and location-dependent than benchmark costs. For example, an office building built 10 years ago in Florida is likely to have similar parametric values to an office building planned in Washington in 2022, while the costs may differ.

Once you set the parameters, you can apply the costs based on the qualitative statements included in the scope of work. Using the examples above, an architecturally interesting visitors center could have high-quality cladding, possibly with a mixture of wood and stone cladding, while a commercial quality office building might have a cladding of GRFC and curtain wall.

This modeling approach is widely used for budget setting. The federal government uses the Parametric Cost Engineering System Software (PACES) software for military construction and the National Cost Management Toolbox (NCMT) for the GSA-owned buildings, which are built on the parametric principles outlined above. Both will generate parameters and offer a user input based on the user's analysis.

Principles of benchmark estimating

We know that benchmark estimating using standardized cost (either published or based on historic comparable projects) is widely used. However, it relies on two significant constraints. The first is finding directly comparable projects with sufficient data that reasonably match the planned project. The second is adjusting the costs to address time, market, location and site-specific factors.

For highly standardized facilities, such as K-12 classrooms, benchmarks can be reasonably reliable sources of information. There is likely to be a statistically acceptable pool of comparable costs, and there is typically a low degree of variation in the benchmark costs: for sophisticated buildings, such as academic science research buildings, even approximate comparability can be difficult to find. The pool of available data may be small, and the dispersion of the data may be high, making it difficult to select an appropriate benchmark model.

Some benchmark systems use refined/sub-divided benchmark data. For example, rather than benchmarking a laboratory building, they apply benchmarks by program, with different benchmark costs for wet, dry and core labs, and for offices, support spaces, building core and shell. These approaches require significantly more data points, and so tend to be proprietary systems. But they can be effective for more complex building types, such as clinics and health care facilities.

The second challenge is adjusting costs for time, market, location and site-specific factors. There are several published indexes that address time and location with varying levels of accuracy, but none that adequately address market conditions or site-specific factors. All published indexes are “basket of goods” indexes, which means they price the costs of specific construction inputs, such as concrete, steel, copper and labor. By doing this, they can’t include differences in bid pricing competitiveness, which can be a large contributing factor to bid prices. They also do not reflect differing “baskets of goods” – an index cannot differentiate between an office and a laboratory, for example. The published indexes also do not generally provide detailed documentation of how costs are adjusted, so it can be difficult to know how to address differing seismic and climate factors, how important they are to the state, and how to address sales tax.

A further thing we need to consider for indexes is the impact of code and practice changes. International Codes are updated triennially. However, the underlying reference material, such as ASHRAE and ASCE standards, can change more frequently. Building codes and practice generally increase costs over time. Although, in some cases, such as accessibility, they have the effect of requiring increased building area, so increase overall cost, but decrease cost per square foot.

Taken together, the indexing challenges mean that benchmark data needs to be as close as possible in time and location to minimize the inherent error contribution of the index. Ideally, data would come from the same area, and not be older than five years. This is not always possible.

Engineering build-up estimate

You can use an engineering build-up estimate when parametric or benchmarking estimates are not possible due to lack of comparability. You can use them for an entire project, or for highly specialized project components. For example, a fish hatchery may be modeled using parametric data, but the related in-water improvements may be so specialized as to require an engineering buildup. It can also be used to address specific costing requirements, such as logistics for a very remote or challenging site. An example was the Johnson Ridge Observatory at Mount St. Helens, where the building was to be developed before completing State Route 504, and within the blowdown area of the National Monument. The logistics needed an engineering buildup estimate, while the building could be modeled parametrically.

Engineering build-up estimates require significantly more investment and more time, which is why you should only use them when needed.

Estimate validation

Whether you generate the estimate using parametric modeling, benchmarking or engineering build-up, the estimate should be validated.

Generally, validation involves the following steps:

- Review the scope to make sure the estimate content is complete.
- Verify the assumptions and conditions of construction.
- Cross check: test the estimate at a high level against published benchmarks.
- Identify distinctive cost drivers.
- Sensitivity testing: change core assumptions to establish how sensitive the estimate is to the underlying assumptions.

For major projects, an accepted best practice is the development of an independent peer review estimate. This is clearly a significant expense, but it can yield significant benefits over the life of the project.

The GAO best practice guide (US Government Accountability Office, 2020) recommends a detailed statistical analysis of the underlying assumptions, using regression analysis, with R^2, F and t tests to ensure that any source benchmarks are statistically meaningful. This is very rare in practice.

Market and project specific estimate

Any estimate that you prepare must reflect the specific market and planned construction conditions, and address identified risks. Market and risk analysis are covered below in the section on *Current best practices for risk management*

Construction conditions that must be addressed include:

- Expected contracting methodology.
- Expected schedule: start date and duration, and any schedule compression that requires premium costs.
- Any anticipated logistics, labor force or supply chain issues.
- Expected site constraints: laydown, staging, hours of operation.
- Environmental considerations or mitigation work.

In many cases, these may not be known. So, you must make reasonable assumptions to provide a baseline for evaluation and possible adjustment. It is not sufficient simply to exclude these conditions as unknown.

Allowances and contingencies

Budget estimates based on preliminary concepts are inherently uncertain. While they may seek to address scope uncertainty through parametric or benchmark estimating, they still need to include allowances for unknown scope items. This is distinct and different from risk and escalation addressed in the next sections.

Typically, you can address scope uncertainty through a combination of allowances and contingencies.

Allowances are scope or line-item specific costs you can include to address specific scope uncertainties. For example, an estimate might contain an allowance for unknown soil conditions, or an allowance for built-in equipment. You can adjust these allowances during design as you more clearly define the scope. Allowances are generally included for work that is expected, but ill defined, as opposed to a possible event.

Contingencies are for broad-based scope uncertainty, where we know there are many small details not yet defined. Typical contingencies include:

- Design (or estimating) contingency to address scope definition during design. This reflects that the estimate can’t foresee and capture all the design details. This is usually set at 10 – 15% at the concept level, although some estimates may have design contingency as high as 30%. The design contingency should reduce to zero as the design is completed.
- Construction (or change order) contingency to address post-contract award changes. This covers change orders that the contractor generates for work within the scope, but that is not covered by the contract documents because of changed conditions or design error/omission. The owner should not use it for discretionary changes. This is usually set at 3% - 5% for new construction and 7% - 10% for remodel.
- Owner change contingency to address owner changes in scope either during design or construction. This can range from zero to 5%.

It is important to note that all estimates include some implicit allowance for undefined scope within the measurements or pricing – we often refer to this as estimate “conservatism.” While this is hard to characterize or quantify, it is important when setting allowances or contingencies to understand the level of “conservatism” or caution. This helps ensure that estimates are not overly cautious or, as a result, too high.

Clearly stated estimate

In addition to being analytically prepared, any estimate must be clear, well presented and defensible. The estimate is a communication tool to allow project team members and reviewers to understand and adopt the estimate (or to challenge and modify it). It is also a historic record of the project knowledge at the time of the estimate generation. The estimate provides a basis for cost trending through the design and provides a post construction audit. As such, it is the initial starting point for the total project cost management best practice.

As noted by GAO, "…well-documented cost estimates can easily be repeated or updated and can be traced to original sources through auditing. Thorough documentation explicitly identifies the primary methods, calculations, results, rationales or assumptions, and sources of the data used to generate each cost element's estimate."

Basis of estimate

The estimate document should contain a statement of the basis of estimate. This should include, at a minimum, the following elements:

- A listing of source documents used for the estimate
- Project description
- Basis for pricing
  - Conditions of construction – contracting methodology, site conditions, etc.
  - Basis of pricing – prevailing wage, sales tax, materials and logistics, overtime
  - Basis for contractor field and home office overhead and profit
  - Contingencies
  - Owner related costs, professional services, fees and assessments
- Schedule and escalation
- Risk and contingency evaluation
- Market evaluation
- Exclusions

Estimate detail

The estimate detail should be presented in sufficient detail to show the thought process behind developing the estimate, and to allow a reviewer to replicate or repeat the process independently.

Estimates should be consistently formatted (required by the state C-100 form) to effectively capture data and compare projects.

Life cycle costing

While life cycle costing is increasingly seen as a best practice, it's still not widely used in actual practice. Published best practices recognize that owners and governmental agencies have an interest in the long-term value created by capital projects. Well written life cycle cost protocols can easily be used across the full range of capital project types, from individual buildings to natural resources projects, and even to non-construction programs.

Life cycle costing should address the following elements:

- Facility operations & maintenance
  - Janitorial, custodial and cleaning costs, both for daily cleaning and for periodic cleaning such as window washing, and building supplies
  - Landscaping and site maintenance

  - Routine (preventative) maintenance, minor repairs, service contracts, etc.
- Utilities
  - Energy (electricity, gas, district heating or cooling)
  - Water, reclaimed/utility water and sewer
- Insurance
- Fees and assessments
- Capital renewal/periodic asset replacement

Life Cycle Cost estimating ensures that a project is not only affordable to build but is affordable to own and operate. It also helps project teams select systems and materials that deliver the best performance for the planned life of the project.

Life cycle costing also offers resilience against low frequency/high impact events, such as flooding, fires and earthquakes. While building codes are designed to protect lives in these events, they do not offer true building resilience. And a code-minimum building may be unusable and nonrepairable after an incident.

Best practices are increasingly focused on a facility's resilience and long-term performance. A recent federal executive order (Executive Order 13961, 2020) mandates that project teams evaluate facility resilience for the federal government.

Current best practices for escalation forecasting

Escalation planning is one of the most challenging elements of budget planning. Construction escalation is very volatile, and highly dependent on local and global market factors. Construction costs are influenced by input pricing, but the nature of construction pricing means the dominant influence is bidder competitiveness and hunger.

Figure 2: construction cost build-up

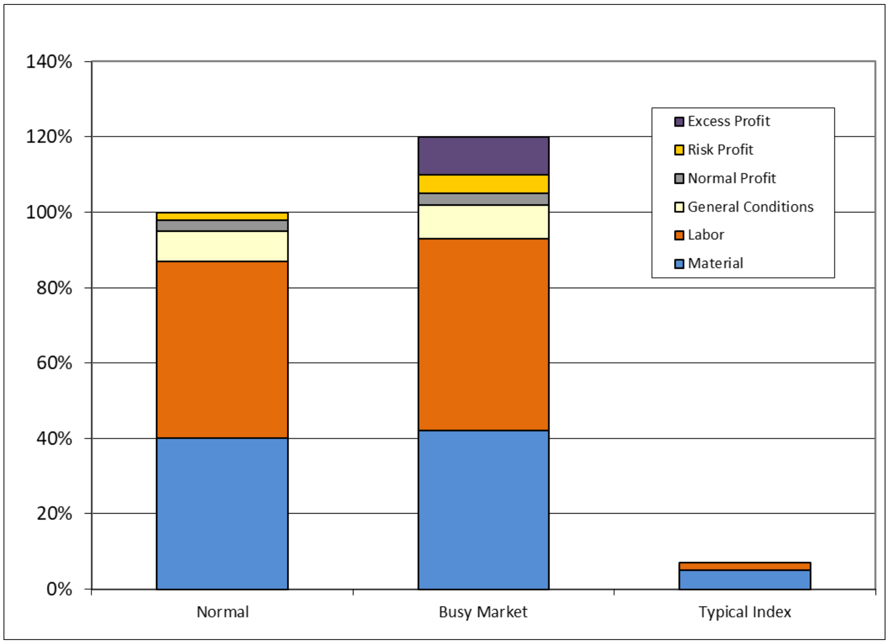
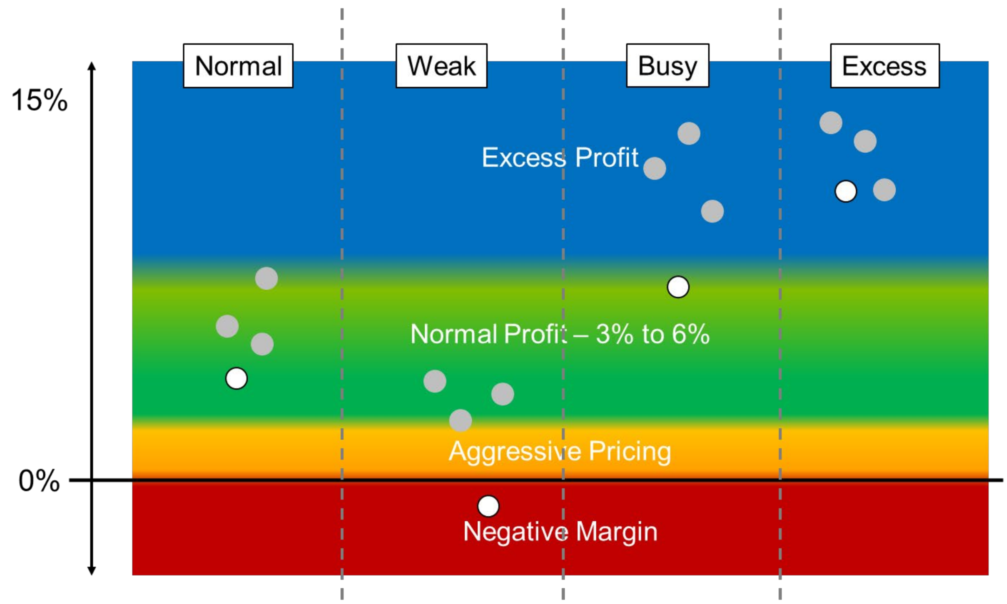


Figure 2 shows the build-up of a typical contractor bid in both a “normal” market and a “busy” market. In a busy market, while input costs of labor and material may rise slightly, bidders can capitalize on a lack of aggressive competition and include excess profit. Their risk also increases since they may have difficulty finding adequate workers. So, they may increase their allowance for risk management. The result is a cost increase significantly greater than the increase in simple input costs. In a similar manner, in weak markets, prices fall further than a change in input costs would suggest as bidders reduce margins (even going negative) in order to keep business in the short term. We illustrated this in *Figure 3: Bid response by market*. The white dot represents the lowest bidder (or Contract Manager at Risk (CMAR) proposal) while the grey dots represent the other bidders. In each case, it is the low bidder who sets the price, even though that may not represent the true market sentiment.

Changes in input cost (and availability) do influence the costs, particularly when the changes are large, like what we see in the current market. This impact is twofold. In the first case, bidders will try to include the increased costs in their bids to the degree that the market will bear the increased costs. The second impact is that bidders may price in fear of future rises, even if prices are currently stable or falling.

Figure 3: Bid response by market



Structure of indexes

Against this backdrop, most major published indexes only follow a small number, or basket, of construction inputs. Figure 2 shows the input costs included in the typical cost index. Other major indexes have larger baskets, but all still miss the impact of shifts in actual bid price, which is almost impossible to measure with any objectivity.

None of the indexes publish forecasts.

Forecasting escalation

Since construction costs are primarily driven by market factors and demand instead of changes in underlying input costs, we can characterize it as "demand pull" rather than "cost push". This means that any forecasting must be more related to assessing demand and likely market conditions, and less looking at input price forecasts.

Current best practices typically require that project sponsors include a market evaluation as part of a project proposal, and at each subsequent estimate review. The market survey instructions for the U.S. Department of Veterans Affairs is highlighted below.

Market reports do not need to be major undertakings. A comprehensive study, as outlined by VA requirements should cost no more than $15,000 to $20,000. Much simpler studies by project sponsors should be done by the project team with one to two days of effort.

Market survey:

Research and documentation of local market conditions that will affect the bid cost. The market survey serves many purposes:

a. Provides information on factors affecting material, labor, and equipment costs.

b. Provides information on potential general and sub-contractors, their capacity to perform the work, and probable interest in competing for the project.

c. Provides information on other project activity that may be competing with the VA project for construction resources. Aids in acquisition planning to determine an advantageous schedule.

d. Provides VA with information to aid in making a decision as to the type of construction contract vehicle that would be most advantageous.

e. Assists in determining an appropriate rate of cost escalation for the local market. Provides VA with authoritative data to support allowances for escalation and market conditions.

f. Serves as a means of informing the local construction community of the upcoming project to generate interest among potential bidders. In other words, markets the project to contractors.

(US Department of Veterans Affairs, 2019)

Managing escalation forecasts

While escalation is often seen as the increase in costs over time, it is also often defined technically by economists as the erosion of buying power over time. This definition is helpful in that it makes the loss of value explicit. When escalation is under-budgeted, it leads to less quality and/or quantity for the proposed capital project. Where escalation is over-budgeted, it leads to capital funds being under-utilized and inefficiently spent.

Escalation includes many factors. Increases in input costs (labor and materials) is only one component. Market competition, risk, and bidder capacity can be far larger drivers. This means that escalation can be markedly different by region and by building type: a large, complex facility, such as a hospital could easily experience appreciably different escalation from a simple, small office building, and the difference could be greater by region. A large market, such as the Seattle area, may have more competition than a smaller market such as the Pacific coast or north east Washington.

Using a single statewide index has the advantage of being simple and creating a uniform protocol across all agencies and regions. It does, however, increase the likelihood of over- or under- estimating the actual escalation needed by a project. This is particularly true in periods of high-cost volatility where published indexes, even well-researched ones, have a high likelihood of error. In the current market, price volatility is so high that no index can honestly claim any degree of accuracy.

Industry best practice recommends that escalation be set based on market assessment, with a risk-based approach that recognizes the uncertainty in forecasts at a project level. The escalation allowance and risk contingency should be routinely reviewed and adjusted to ensure that the project is adequately, but not excessively funded.

Washington’s current approach could be adapted to include project specific contingencies to address potential inflation in excess of the selected index value. Any project specific contingency could be proposed by the project sponsor, based on a market analysis, and reviewed and approved by OFM. To ensure that the contingency is not used for other purposes, we recommend that it be held outside the project budget and limited solely to addressing escalation issues. Alternatively, there could be expedited budget augmentation at a legislative level

Current best practices for risk management

All major sources of best practices place a high emphasis on risk evaluation. A Department of Defense handbook (UFC 3-740-05 Handbook: Construction Cost Estimating, 2020) (Department of Defence, 2020) dictates that all projects include a risk assessment, and that the project undertakes a form Cost and Schedule Risk Assessment (CSRA) where significant risks are identified. It is also important to include opportunities in any risk evaluation. Opportunity evaluation follows the same fundamental steps but looks for ways to exploit the uncertainty rather than avoid the consequences.

At the budget planning stage, risk management can appear daunting and expensive, but it does not need to be either. A team can perform and document a basic risk assessment within a very short period (one to two days). This can happen at a very low cost and the return on investment is substantial.

The key outcome is to increase confidence in the budget by exploring and addressing uncertainties. One of the greatest values from undertaking even the simplest risk assessment is when the project team identifies and names areas of concern, and then addresses them openly.

Nature of risk

As we noted in Figure 1, there are two main sources of uncertainty in a project: scope uncertainty and market uncertainty.

Scope uncertainty is essentially *epistemic risk,* which is risk that we can reduce through further knowledge. You must include allowances and contingencies to manage the uncertainty while it exists, but these things should progressively reduce as you define the scope.

Market uncertainty is essentially *aleatoric risk*, which is external risk to the project and can't be reduced through knowledge. Escalation, weather, market changes and COVID-19 are all examples of this risk type. While the degree of uncertainty reduces as the time for bidding approaches, the risk remains external to the project team.

For both types of risk, the essential approach is the same: to identify and characterize the risk, to establish a management approach, and to implement it.

Risk identification and characterization

The starting point in all risk management is identifying and characterizing the risk. This can be done informally within the project team, or through a more structured approach using risk questionnaires and risk workshops. The goal is to identify and document reasonably foreseeable and relevant risks, and to characterize them by establishing likelihood and impact.

Example 3: Risk identification and characterization

Risk identification and characterization example

Example 1 (epistemic)

The access to the site is currently undefined. If the contractor can't get access directly from A Street, they will have to obtain an easement across "xyz" property, construct a new service road and remove it at the end of construction. The likelihood of needing this access route is high, and the cost is in the range of $3 - $5 million

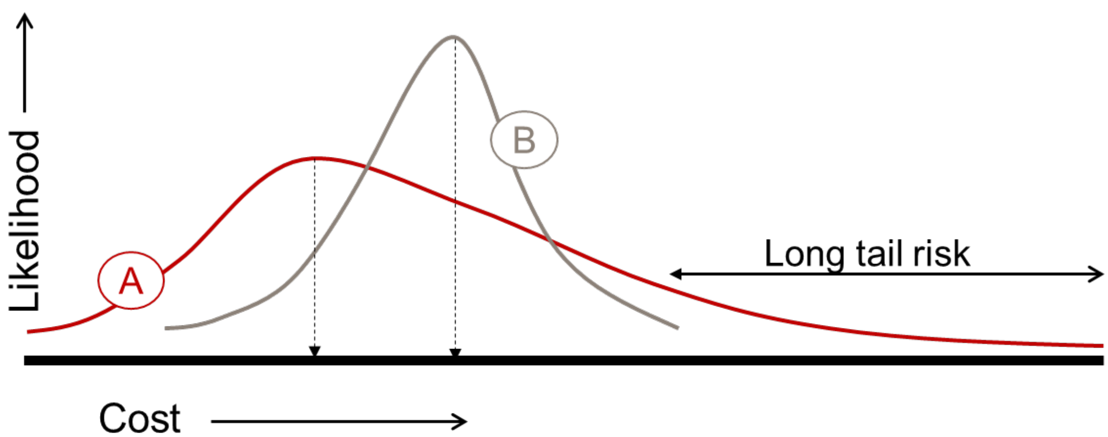
Example 2 (aleatoric)

The proposed site may contain unmapped but significant Native American archaeological sites. There is no surface evidence, but other project teams have found such sites in this area. The likelihood is moderate. If found, the cost could range from $100,000 for documentation and recovery, to over $15 million if you find a major site and have to suspend work during evaluation and a detailed recovery process.

In concept planning, the risk identification and characterization does not need to be intensive or complicated. The intention is to make a reasonable assessment of what might impact the project, and how that would impact budget planning. Likelihood is usually described qualitatively using a low to high rating. Quantitative likelihood can be used in larger or more detailed evaluations.

In the second example above, the range is very wide. An important part of characterizing these kinds of risk is developing a risk profile. Analytically, these represent a probability distribution. But it is not necessary to undertake a sophisticated statistical assessment to make a judgment as to the broad shape of the distribution. In Figure 5, Profile A shows a distribution that has a small, but real possibility of a high cost, often referred to as a long tail risk. But overall, the bulk of the risk is quite low. Profile B has a much narrower range but the bulk of the risk is higher.

Figure 4: Risk profiles



At the budget stage, it is important to remember that the goal is to gain a broad understanding of the uncertainty so you can establish confidence in the numbers —not to provide a detailed assessment. If nothing else, the recommended best practice is to provide a “three-point estimate,” which establishes low (minimum credible), most likely and high (maximum credible) estimates.

Figure 5: Likelihood/consequence matrix

		Severity (Consequence)				
		1	2	3	4	5
Likelihood	5					
	4					
	3					
	2					
	1					

Another common tool in the characterization step is a likelihood/consequence matrix. This has the advantage of showing risk choices graphically, and also highlighting the combined threat. Risks that score in red need more direct focus and attention than those in the green.

Each project will establish quantitative values for severity. For a $10 million project, a severity level of 3 may be $100,000, but for a $100 million project, it may be $2 million. The values are subjective and are not as important as the scoring process.

The characterization should also develop a risk narrative that looks at the following questions:

- What will trigger the risk? What are the precursors?
- What follows the risk? What are the dependencies?
- What risks are correlated or mutually exclusive?
- When will the risk expire?

Risk Actions

Once teams have identified and characterized the risks, the project team must establish planned actions. At the budget concept stage, these are intended to be high level. However, these need to be carefully thought about.

The four, broad levels of response action are listed below in order of priority:

1. Mitigate the risks by reducing the uncertainty or negative impact.
2. Optimize the risk allocations.
3. Diversify the risk through insurance or by pooling risk across programs.
4. Cushion the risk through contingency.

As we noted, contingency is the least preferable option. But it is the easiest to apply at the budget planning stage.

Teams can plan mitigation but it is unlikely to be mature or complete enough to embed in the initial budget. In many cases, targeted allowances may be the best approach, with the allowances being adjusted as teams eliminate risk. Mitigation should still be considered during budgeting, particularly for making key planning decisions. For example, one site may be selected over another because it reduces the uncertainty of site conditions.

Teams should also consider optimization during the budgeting stage. Most often, this involves selecting a procurement process that optimizes risk allocation for the specific project needs. Recently a process called Value for Money (VfM) analysis has become more widely used. VfM is a structured, analytical, risk-based process that evaluates allocated and retained risk for each option. The recent Infrastructure Investment and Jobs Act (IIJA) (Infrastructure Investment and Jobs Act, 2021) now mandates Value for Money for certain projects funded by the IIJA. VfM is quite challenging to apply and requires significant investment in a trained team. In consequence, VfM is unlikely to be worth the investment for the majority of state capital projects, but it should be considered.

Diversifying risk is rarely of interest at the budget planning stage.

Once teams have mitigated, allocated or diversified risks, the remaining risk should be managed through contingency. Most best practices recommend the use of quantitative, analytical methods, such as Monte Carlo simulation to establish probabilistic levels of confidence. Monte Carlo simulation is a computer-based process for evaluating complex probability analyses. It works by assigning probability distributions to each individual identified risk, and then running a very large number of simulations using random inputs. The outcomes of each run are summed to develop a project-wide probability distribution. Monte Carlo simulation software is widely available, including as common spreadsheet add-ins, but is not easy to use well. Because of this, such simulations may be appropriate for more complex projects but would be rarely valuable for the majority of state capital projects. In most cases, a contingency based on a subjective assessment of risk is adequate, with contingency being adjusted up or down to reflect identified risks.

Appendix A Best practice sources

ASTM Standards

There are several ASTM Standards related to cost estimating, these include the following. Since ASTM standards are usually single topic, the number of standards which cover best practices is very large. Standards shown in **bold** are the more pertinent.

E 631	**Terminology of Building Constructions**
E 833	Terminology of Building Economics
E 917	Practice for Measuring Life-Cycle Costs of Buildings and Building Systems
E 964	Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems
E 1057	Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems
E 1074	**Practice for Measuring Net Benefits and Net Savings for Investments in Buildings and Building Systems**
E 1121	Practice for Measuring Payback for Investments in Buildings and Building Systems
E 1185	Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems
E 1369	Guide for Selecting Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Buildings and Building Systems
E 1557	**Classification for Building Elements and Related Sitework—UNIFORMAT II**
E 1699	Practice for Performing Value Engineering (VE)/ Value Analysis (VA) of Projects, Products and Processes
E 1765	Practice for Applying Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Projects, Products, and Processes
E 1804	**Practice for Performing and Reporting Cost Analysis During the Design Phase of a Project**
E 1946	**Practice for Measuring Cost Risk of Buildings and Building Systems and Other Constructed Projects**
E 2083	**Classification for Building Construction Field Requirements, and Office Overhead & Profit**
E 2168	**Classification for Allowance, Contingency, and Reserve Sums in Building Construction Estimating**
E 2204	Guide for Summarizing the Economic Impacts of Building-Related Projects
E 2514	**Practice for Presentation Format of Elemental Cost Estimates, Summaries, and Analyses**
E 2691	Practice for Job Productivity Measurement
E 2013	Practice for Constructing FAST Diagrams and Per- forming Function Analysis During Value Analysis Study

Agency cost estimating guides

Government Accountability Office (GAO)

Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs (US Government Accountability Office, 2020)

The GAO is an office established by Congress to provide timely, fact-based, non-partisan information. They also are the leading audit institution for the Federal government. In that role they publish a cost estimating guide that is used to support budgeting by Federal agencies, and to audit their processes. The guide is an excellent summary of best practices for estimating in general, but since it covers all types of Federal procurement, not just construction projects, many of the best practices are more suited to major agency programs than to construction. The best practices are also defined at a high level, for specific agencies to write specific procedures to comply. As such, they provide a good theoretical basis, but not specific guidance.

United Facilities Criteria (UFC)

UFC 3-740-05: Handbook Construction Cost Estimating (Department of Defence, 2020)

UFC documents are publications related to US military construction, published on the Whole Building Design Guide (WBDG) site. UFC 3-740-05 contains the guidance for all military construction. Different branches have supplemental guides, but the core principles and procedures are well documented in this handbook. It is based on following the GAO guide requirements.

General Services Administration (GSA)

1000.6 PBS P-120, Public Buildings Service Cost and Schedule Management Policy (US General Services Administration, 2016)

The GSA P-120 is a detailed estimating guidance for GSA projects. It embodies best practices, but is focused on procedures, which means it is indicative of best practices, but not particularly informative for review

Measurement standards

measurement standards are not directly a part of best practices but are key to developing reliable budgets since differing measurement approaches will impact estimates. A recommended best practice is to harmonize measurement standards to ensure data consistency for benchmarking

National Center for Education Statistics (NCES)

Postsecondary Education Facilities Inventory and Classification Manual (National Center for Education Statistics, 2006)

The Postsecondary Education Facilities Inventory and Classification Manual, often abbreviated to FICM is widely used for academic building planning. Most higher education systems and institutions include a form of it in their measurement guidelines, although not all will show the original source. The greatest advantage of the document is the detailed guidance on measuring Assignable Area, which is at the heart of all functional planning

US General Services Administration (GSA)

National Business Space Assignment Policy (US General Services Administration, 2017)

The GSA National Business Space Assignment Policy provides very detailed guidance on measurement of spaces. It mirrors BOMA for the commercial aspects of real estate, but also includes rules on Assignable Space, much as the FICM document. It would be an ideal basis for measurement, except that it is likely that FICM is already in use by some of the agencies in Washington State.

Building Owners and Managers Association (BOMA)

BOMA 2018 for Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3—2018) (Building Owners and Managers Association International, 2018)

The BOMA standards are widely used in commercial real estate. In addition to the ANSI/BOMA standard listed above, there are several standards for specific building types, including office, retail, commercial and industrial facilities. The standards are useful for measuring gross and leasable area, but do not align for measurement of assignable area.

Appendix B Uniformat Levels

Uniformat is published by ASTM in their document *E 1557 Classification for Building Elements and Related Sitework—UNIFORMAT II*.

Uniformat is a standard for classifying and coding construction elements. Elements are major functional components of a building, such as foundations, exterior cladding, electrical systems, etc. The elements are broken down by their function, as opposed to design or material. Functions are usually defined in a “verb-noun” format. For example, Foundations “transfer load” – regardless of whether the foundations are made of concrete or steel piles.

The standard is broken down into a hierarchy of four main levels, with the ability to subdivide further as needed at the detailed level.

Level 1 is made up of seven **Major Group Elements** labeled A – G.

Level 2 subdivides each of the **Major Group Elements** into up to five **Group Elements** labeled 10 – 90

Level 3 subdivides each or the **Group Elements** into up to eight **Individual Elements**, using an additional two numeric fields.

For example:

Major Group Elements		**Group Elements**		**Individual Elements**	
C	Interiors	C10	interior Construction	C1010	Partitions
				C1020	Interior Doors
				C1030	Specialties/Fittings
		C20	Stairs	C2010	Stair Construction
				C2020	Stair Finishes
		C30	Interior Finishes	C3010	Wall Finishes
				C3020	Floor Finishes
				C3030	Ceiling Finishes

Bibliography

Building Owners and Managers Association International. (2018). *BOMA 2018 for Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3—2018).* Retrieved from https://www.boma.org/BOMA/BOMA-Standards/BOMA_Floor_Measurement_Standards/Gross_Areas/BOMA/BOMA-Standards/BOMA_Floor_Measurement_Standards/Gross_Areas.aspx?hkey=4a4b9cbe-9017-4ca5-a020-3abfe23d5227

Department of Defence. (2020). *UFC 3-740-05 Handbook: Construction Cost Estimating, With Change 2 .* Whole Building Design Guide. Retrieved from https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-3-740-05

Department of Veterans Affairs. (2019). *Manual for Preparation of Cost Estimates & Related Documents.* Retrieved from https://www.cfm.va.gov/cost/index.asp

Executive Order 13961. (2020). *Governance and Integration of Federal Mission Resilience.* Federal Register. Retrieved from https://www.federalregister.gov/documents/2020/12/10/2020-27353/governance-and-integration-of-federal-mission-resilience

Infrastructure Investment and Jobs Act. (2021). Retrieved from https://www.congress.gov/bill/117th-congress/house-bill/3684/text

National Center for Education Statistics. (2006). *Postsecondary Education Facilities Inventory and Classification Manual.* Retrieved from https://nces.ed.gov/pubs2006/2006160.pdf

US General Services Administration. (2016). *1000.6 PBS P-120, Public Buildings Service Cost and Schedule Management Policy.* Retrieved from https://www.gsa.gov/directives-library/p120-public-buildings-service-cost-and-schedule-management-policy-10006-pbs

US General Services Administration. (2017). *National Business Space Assignment Policy.* Retrieved from https://www.gsa.gov/real-estate/design-construction/spatial-data-management/national-business-space-assignment-policy

US Government Accountability Office. (2020). *Cost Estimating and Assessment Guide, GAO-20-195G.* Retrieved from https://www.gao.gov/products/gao-20-195g

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