
BEST PROCESS MAP FOR OBTAINING THE OPTIMUM VALUE FOR A FUTURE INVESTMENT

ABSTRACT-

Investors always look for the optimum return of the capital invested. They still run feasibility studies to determine which is the best alternative among different projects that offer the best IRR, VPN, ROI, ROCE, or other financial scoring models.

Some projects or programs get rejected because of the value of the alternative chosen is high, and sometimes the process for estimating and budgeting does not obtain the optimum result.

What is the best process for estimating and budgeting that could help owners to get the optimum value for acquiring, constructing, updating, expanding upon, maintaining, repairing and eventually disposing of organisational assets?

What are the advantages or strengths that this process can offer compared to others?

The following research answers this question, through the analysis of project management entities that suggest processes for Cost Estimating and Budgeting.

Guild of Project Controls offers the best processes for an estimating and budgeting calculation. It also provides, some strengths as Owner and Contractor's perspective, Bottom-Up and Top-Down estimates and an additional horizontal and vertical validation before assessment, to determine that all data is reliable and it considered all resources and costs.

This process complies with most of what owners look for the development of a cost estimate to guarantee that the outcome is almost the closest one to reality.

KEY WORDS- Cost Estimate, Budgeting, Project Estimates, Process Map, Continuous Improvement Model, Simulation, Risk Analysis, Sensitivity Analysis.

INTRODUCTION-

Investors always look for the optimum use of their money. They run feasibility studies to determine the best alternative that meets their requirements. Depending on the sector and companies' policies for portfolio management, they have gates or steps to determine if they continue analysing in detail the best option and finally make a decision of the Go or No Go of the project.

They set the opportunity cost to evaluate if the best alternative chosen meets the internal rate of return (IRR) and the net present value (NPV) set in the requirements, as other indicators. Also, there are additional requirements that the future asset or investment does comply with environmental, legal, social and other aspects required by law.

Sometimes most of the projects in a portfolio's investment do not pass through the intermediate or final gate, and investors reject them because alternatives do not comply with investor's expectations.

Why are these studies rejected? Why owners or investors do not approve feasibility studies?

In most cases, investment does not comply with profit expected, feasibility studies do not meet investors' portfolio strategy for growing into market shares or for increasing revenues, these studies also do not meet shareholders' expected cash flows or final report plan does not comply with law's requirements, or the realization of other corporate strategic benefits.

Regarding profit expected, portfolio strategies and cash flows, why these investments do not comply with these indicators?

When elaborating the cost estimate, we find out that the process for Estimating and Budgeting produced a very high value – or a low value-, the alternative is chosen and is too expensive, or estimators did not optimise the resources required for its construction during the calculation of the CAPEX. Also, IRR or NPV is too high or too low, depending on the value of the investment, so the alternative generates a cash flow that does not meet expectations.

Are these causes part of an inefficient or incomplete process for Estimating and Budgeting?

The following research focuses on determining what process map from project management entities, known by the author, might be the best that produces the most optimum outcome to satisfy the owner's expectations.

A second analysis will be conducted to determine the strengths and weaknesses of each processes map. This analysis will help us to identify what main differentiators are between processes and also to suggest improvements at each of them.

Besides, it is essential to understand that a good process, as it is iterative in most cases, requires that the process allows to get improvements during the iterations, or at least the flow process lead the team to find the optimum solution.

This research is also useful for owners to understand what a good process for estimating and budgeting requires to meet best practices in estimating and budgeting to obtain the best alternative for your future assets.



Therefore, this research will be addressed to answer the following question:

- What is a good Process for Cost Estimating and Budgeting?
- What are the strengths and weaknesses of the selected process?

METHODOLOGY-

Step 1

During the life span of an asset, it is required to determine if the budget estimated will be enough or it might need more funds. An optimum estimate is a result of a good process for Estimating. How can we guarantee that the Estimating Process chosen can be validated?

We can determine which Cost Estimating and Budgeting Process Map used in the project management sector offers a better approach to guarantee a good outcome.

From an Owner's perspective, decision gates are implemented to evaluate the asset's feasibility. Feasibility studies presented to the committee board, and then they might reject investment alternatives because they do not comply with investors' requirements or companies' strategies or investment's policies.

This decision requires a revision (or several revisions) of final feasibility study reports to comply with investor's expectations.

For this main reason, usually, when elaborating a Cost Estimate, the first outcome is not the final one. It requires several versions ("progressive elaboration" at each phase gate of the asset life span) to get closer to the most realistic projected final cost estimate for the execution of the future asset. Then this last result is evaluated to determine if it meets investor's criteria. These revisions will produce changes in several deliverables that are important to feed the Cost Estimate.

If we take as a reference the "Cost Estimating Requirements Handbook" from National Park Service (NPS) a federal agency from the United States of America, NPS proposes 3 Classes of Estimates as follows:

- Class A Construction Cost Estimates: For the Construction phase, with an accuracy range of -5% to +15%
- Class B Construction Cost Estimates: For the Design phase, with an accuracy range of -15% to +30%
- Class C Construction Cost Estimates: For the Conceptual phase, with an accuracy range of -30% to +50%

Each of these classes recommends a list of documents to prepare to deliver a cost estimate.

As we want to analyse a full life span, we expect a Cost Estimate that contains most of the scope defined. Under these circumstances, a Class A Cost Estimate from NPS offers a full scope defined and the documentation required to deliver the cost estimate, varies during its elaboration as follows:

- Draft 100% Construction Documents
- 100% Complete Construction Documents
- Final Construction Documents



Final Construction Documents are:

- Architectural building designs (100% drawings)
- Final Site improvement plans
- Mechanical, Electrical and Plumbing Systems Designs
- Final Structural Design
- Complete Project Specifications
- Mark-ups and Design Contingencies
 - o Location Adjustments
 - o Design Contingency
 - o General Conditions
 - o Historic Preservation Factor
 - o Overhead & Profit
 - o Bonds & Permits
 - o Contracting Methods Adjustment
 - o Inflation Escalation
- Work Breakdown Structure
- Basis of Estimate
- Project Summary
- Bid Item Summaries
- Line Item Cost Summaries

What process can guarantee that most of the documents and deliverables will produce an optimum cost estimate?

We are going to evaluate what process for Estimating and Budgeting might be the best.

Step 2

We have chosen the following entities:

1. AACE International: Cost Estimating and Budgeting Process Map from Total Cost Management Framework
2. Guild of Project Controls: Overall Cost Estimating and Budgeting Process Map
3. Government Accountability Office: Cost Estimating Process
4. American Society of Professional Estimators: Standard of Practice
5. Project Management Institute: Project Management Body of Knowledge – Project Cost Management

Step 3

Each entity promotes the following Processes Map:

1. Total Cost Management from AACE International suggests the following Process for Cost Estimating and Budgeting:



3. GAO suggests the following Cost Estimating Process:

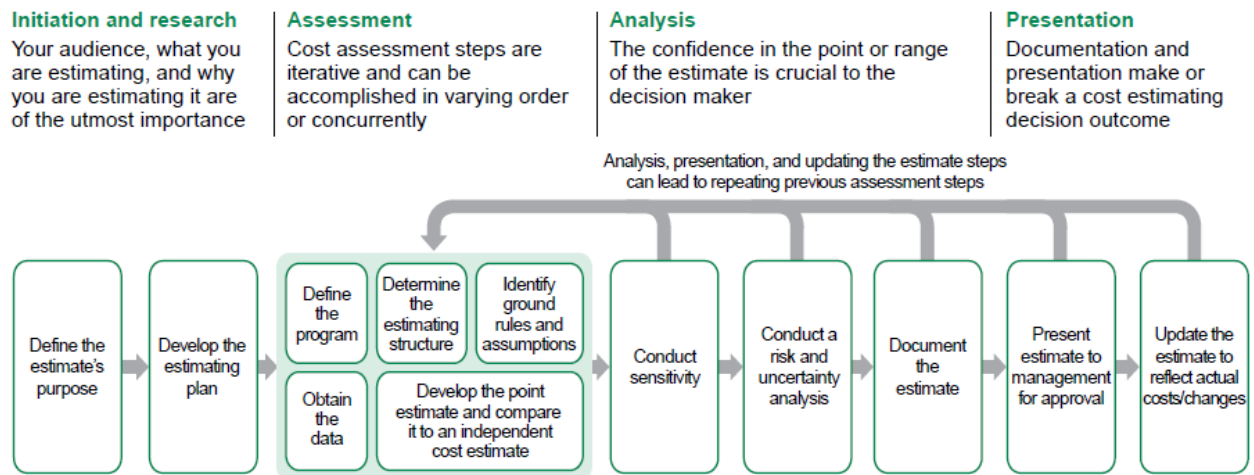


Figure 3 Cost Estimating Process³

4. ASPE suggest the following Process Map:

³ GAO Cost Estimating and Assessment Guide- Best Practices for Developing and Managing Capital Program Costs. Page 8

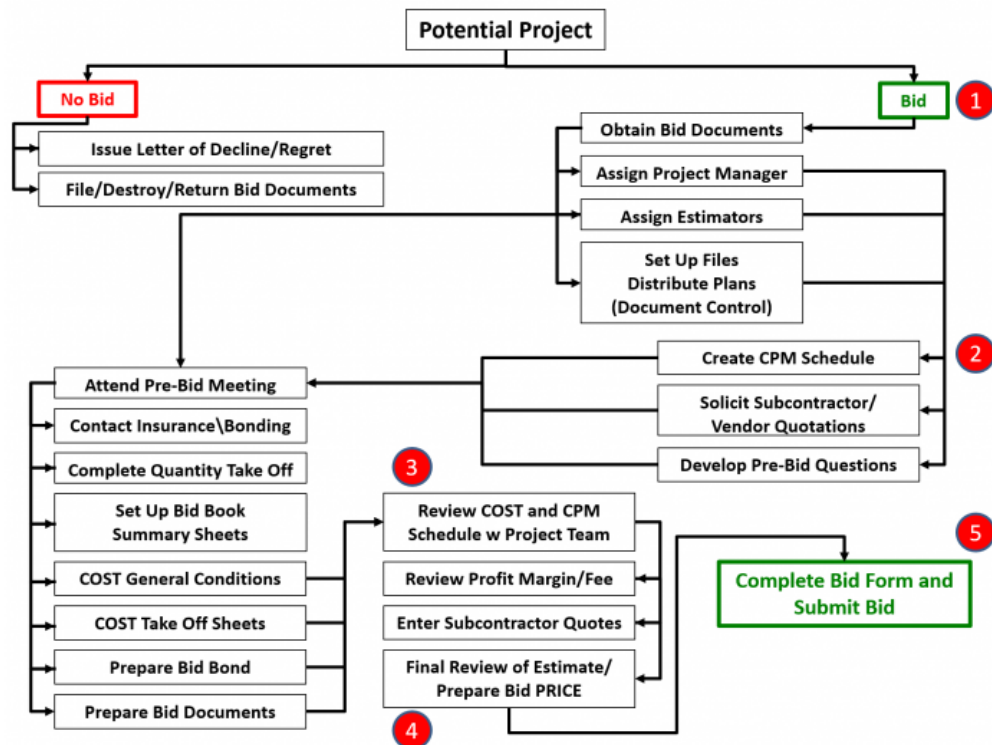


Figure 22 - American Society for Professional Estimators (ASPE) Standard of Practice

Source: Adapted from the American Society for Professional Estimators (ASPE) Standard of Practice

Figure 4 Standard of Practice for Estimating⁴

5. Project Management Institute: Project Management Body of Knowledge – Project Cost Management:

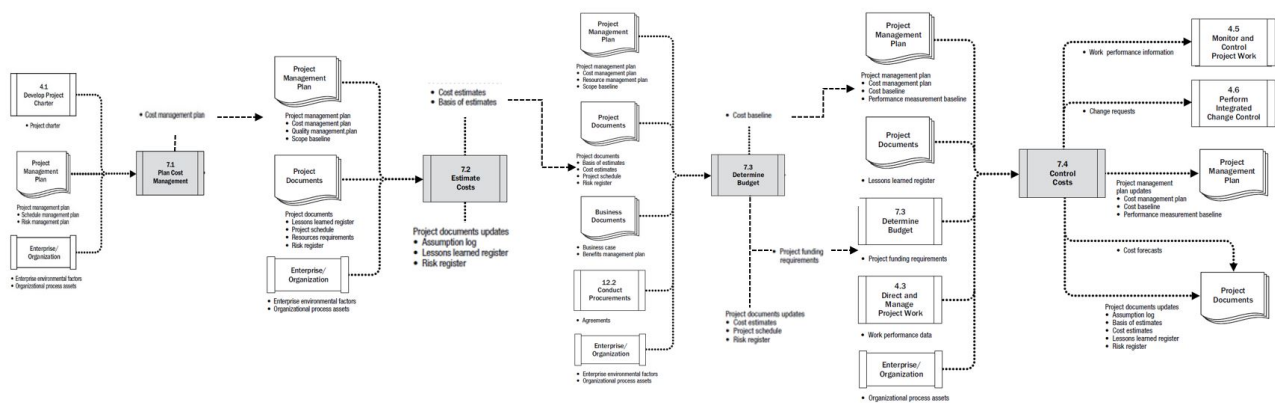


Figure 5 PMI's Cost Management Process Map⁵

⁴ Guild of Project Controls. (2015, October 03). 08.01 Introduction to Managing Cost Estimating Budgeting Rev 1.03. Retrieved September 15, 2018, from <http://www.planningplanet.com/guild/gpccar/introduction-to-managing-cost-estimating-budgeting>

⁵ A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 6th ed. Newton Square, Pa: Project Management Institute, Inc. 2017. Page 231- 270

Step 4

We have made a table to compare processes between each other. We have added a column at the left of the table to show the outputs produced in each process. A red line represents the end of a process.

We have also coloured cells or group of cells, and that represents the following:

1. Green: The process or group of processes exist, or another process includes these processes of the Estimating and Budgeting process map.
2. Yellow: The outcome is produced by another process not included in the estimating and budgeting process map.
3. Red: The outcome is not produced at all by any process.

This method will show us that, the more green cells a process map has, the most complete a process map is over the others.

If also the process map contains a few yellows cells, it is a good indicator that the process delivers the outcome.

OUTPUT	TCM	GPC	GAO	ASPE	PMI
Plan	Plan for Estimating and Budgeting	- Overview of Cost Estimating and Budgeting - Develop a Cost Estimating and Budgeting Policies and Procedures Manual	- Define Estimate Purpose - Develop Estimating plan	Obtain Bid Documents	Plan Cost Management
				Assign Project Manager	
				Assign Estimators	
				Set up Files / Distribute Plans (Document Control)	
				Create a CPM Schedule	
				Solicit Subcontractor/ Vendor Quotations	
				Develop Pre-Bid Questions	
				Attend Pre-Bid Meeting	
				Contact Insurance/Bon ding.	

OUTPUT	TCM	GPC	GAO	ASPE	PMI
Estimate and Quantity Take-Off	- Quantify the Scope Content (take-off) - Cost Scope Content - Price the Cost Estimate	- Define the Estimate Purpose and Scope of Work (Owner) - Developing Top-Down Cost Estimate (Owner) - Define the Estimates Purpose and Scope of Work (Contractor) - Developing Bottom-Up Cost Estimate (Contractor) (ABC)	- Define program characteristics - Determine Estimating structure - Identify rules and assumptions - Obtain Data - Develop point estimate and compare it to an independent cost estimate	- Complete Quantity Take-off - Set up Bid Book Summary Sheets - Cost General Conditions - Cost Take-off Sheets	Estimate Cost
Estimate Validated	1.1	Validate the Time Cost Trade-Offs Validating Horizontal and Vertical Traceability (Costs)	Develop point estimate and compare it to an independent cost estimate		5.1
Assessment of Estimate	Simulate and Optimize the Costs	Conducting the Cost Risk Analysis	Conduct sensitivity analysis Conduct risk and uncertainty analysis		5.2
Budget	Budget Costs	2.1	3.2		Determine Budget
Cash flow	Analyse Cash Flow	2.2			5.3
Documenta tion of Estimate. Baseline for control	Review and Document the Estimate 1.2	Baselining and Communicating the Cost and Loaded Schedule	Document the estimate		5.4 5.5
Approval of Estimate	1.3	2.3	Present estimate to management for approval		5.6

OUTPUT	TCM	GPC	GAO	ASPE	PMI
Submission of Estimate for Tendering	Bidding the Cost Estimate	2.4	3.3	4.2	5.7
Control of Estimate	Develop and Maintain Methods and Tools	Capturing Progress and Updating Schedule Assessing and Interpreting Progress Project Performance Forecasting	Update the estimate to reflect actual costs and changes		Control Costs

Table 1 List of Processes from each entity⁶

The following notes will explain why cells are in green, yellow or red.

1. Total Cost Management

1.1. "Validation" happens during the "Review and Document Estimate" process.

1.2. "Baseline" happens during the "Budget Costs" process.

1.3. "Approval" happens during Project Implementation Process, during the "Authorize and Accept Project" process. The process map shown does not include this process.

1.4 "Control of Estimate" is not part of the current process. "Develop and Maintain Methods and Tools" is a process to collect data and create a database for future estimates. To control the Estimate, we can find the process in Chapter 8- Project Control Plan Implementation, Chapter 9 – Project Control Performance Measurement and Chapter 10 – Project Control Performance Assessment.

2. Guild of Project Controls

2.1. "Budget" happens in the process 08.4.3.10 Budget, Authorization or Control (GPC Level 3 Cost Estimate), 08.6.3.2 Contractor Cost Baseline, Bid or Tender - (GPC Level 5 Cost Estimate) and 08.10.3.1 Communicate the Cost Estimate / Cost Budget

2.2. "Cash Flows" happens in process "09.3.3.2.3 Reviewing Both Owner and Contractor Cash Flows" which is a process included in "Measuring Capturing Progress Updating the Schedule" Module. The Process Map shown does not include this process.

2.3. "Approval" happens in process "Define Top-Down Cost Estimate (Owner)" in the sub-process 08.4.3.10 Budget, Authorization or Control (GPC Level 3 Cost Estimate) for the OWNER and in the process "Developing Bottom-Up Cost Estimate (Contractor)" as an output for the CONTRACTOR.

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2.4. "Tendering" happens during "08.6.3.3 What is Activity Based Costing" with a note that it also appears in 05.4.3.6 Contractors Cost Estimating, Budgeting and Bidding Process

3. Government Accountability Office

3.1. GAO's process "Develop point estimate and compare it to an independent cost estimate" was split in two, "Develop Point Estimate" and "Compare it to an independent cost estimate". So, it can be equivalent to the validation processes of GPC.

3.2. "Budget" and "Analyse Cash Flow" happen during "Develop Point Estimate" process.

3.3. "Tendering" is not mentioned in GAO's guide.

4. American Society of Professional Estimators

4.1. It does not show any process after finishing Cost Estimate and Quantity take-off.

4.2. "Tendering" can be included in the process of "Set up Bid Book Summary Sheets".

5. Project Management Institute

5.1. "Validation" happens during the "Estimate Cost" process. The process includes a Decision-Making technique to vote for the best outcome. See section 5.2.2.4 of the PMBOK.

5.2. "Risk Analysis" happens during the "Estimate Cost" process. As shown in the flow, the Risk Register is updated as an output of the process.

5.3. "Analyze Cash Flow" happens during the "Develop Schedule" process. The output "Schedule Data" contains information about cash flow projections.

5.4. "Documentation" happens as a result of "Estimate Costs". The Basis of Estimate is a result as part of Project Documents.

5.5. "Baseline" happens as a result of "Determine Budget" process.

5.6. "Approval" happens during the "Determine Budget" process.

5.7. "Tendering" is not mentioned at all as a result of the Cost Management Process. The Procurement Management Process refers it as an output for request proposals.

Based on the table, we can assess which one offers a complete process to deliver most of the outputs required to do a cost estimate.

What are the strengths and weaknesses of the complete processes?

FINDINGS-

Step 5

As we can observe from first hand, only one process map does not offer any simulation process, sensitivity analysis or risk analysis to identify potential improvements in the cost estimate. ASPE suggests just a revision in the cost



estimate, but it is not clear what kind of revision the project team must conduct. It may be necessary to develop more in detail what type of revision the project team will execute.

PMI offers an update of a risk register, but it is not obligatory to assess risk during the elaboration of the estimate. Although it has most of the green cells, compared to GPC and GAO, most of the processes are not independent.

On the other hand, TCM, GPC and GAO include in their flow a simulation process (TCM) or sensitivity analysis and risk analysis (GPC and GAO).

Based on this first filter we can analyse the Strengths and Weaknesses of the remaining processes map as follows.

The analysis made from Table 1 List of Processes from each entity, shows which processes dominate over others. Besides, we evaluated the list of tasks, methods and tools used in each process and listed in Table 3 List of Tasks, Methods and Tools for each Process Map in Appendix 1. These two tables will help us to determine what strengths have each Process Map.

	TCM	GPC	GAO
Strength	PDCA Process Phased oriented for Authorization and Funding It applies at any step of the Asset Span or Project Life Span. Includes Cash flow and Rates of Investment Create Database to develop future estimates	Argyris and Schon double loop learning Asset Life Span and Project Life Span There are all processes to produce outputs requested for an estimate. GPC can be applied independently of the Step for Authorization and Funding of the Life Span and Project Life Span. Owner and Contractor perspectives Participation of all stakeholders Bottom-Up Estimate and Top-Down Estimate Horizontal and Vertical Validation of Schedule Interfaces between Owner and Contractor Value Analysis or Engineering for Owner and also for Contractor	Each task contains a detailed description of methods and tools. Participation of all stakeholders Includes a check-list to help estimator or auditor to validate each process. Can be easily audited. Product-Oriented WBS Exhaustive Data validation Identification of Cost Drivers Conduct Sensitivity Analysis of Cost drivers to determine ranges before Risk Analysis Standardised structure for the estimate Validation can lead to a repetition of previous processes. Implementing Surveillance Organisation Focus on Accuracy and Credibility

		Templates for Owner and Contractor estimates Standardised structure for the estimate Exhaustive validation previous to Assessment Validation can lead to a repetition of previous processes. Focus on Accuracy, Precision and Reliability of the Estimate	with a checklist (Table 26)
Weakness	Tasks are not listed. Process do not contain methods and tools. They appear at the end of the chapter. Control of Progress and Update of Schedule are not part of the process. Develop only Top-Down Estimate Only mentions doing an independent review	Cash flow is in another process. There is not any checklist at the end of each process. More effort to elaborate an estimate	It is not phased-oriented. It does not have a contractor's perspective for preparing Bid Estimates. Develop only Top-Down estimate More effort to elaborate an estimate

Table 2 Strength and Weakness of Process Map⁷

Step 6

As observed in the table above, GPC and GAO have more strengths than TCM. One of the main reasons, that helped a lot for the current analysis is that both processes contain a detailed explanation of each tool and method used to process inputs at each step. This similarity was an advantage compared to TCM.

For the author, it was easy and quick to follow TCM because there is a brief description of each process and there is not any mention or explanation of how to apply any method or any tool. TCM lists Recommended Practices at the end of the chapter, and each Recommended Practice shows methodologies and tools to process project data. An improvement for TCM would be to link Recommended Practices to each process.

It is important to highlight that GPC has a perspective from Owners and Contractors. Which is relevant because for an Owner, when integrating contractor's estimates, schedules and WBS, it does not matter at which step the

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project team is in your Authorization and Funding step. The link and standardisation of structures between Estimate, Schedule and WBS at different levels allow Owner and Contractor to interface efficiently.

Another interesting concept in GPC is "Decision Support Package" which is a document that has to be approved to move to the next phase. This document is similar to "Final Report" at each gate, which consolidates all the information requested by the Steering Committee for budget approval.

Another differentiator between GPC and GAO is that GPC has a Bottom-Up estimate for Owners and a Top-Down estimate for Contractors, which increase data of the Estimate, providing more information about resources and cost.

Another remarkable differentiator between GPC and GAO is the Horizontal and Vertical validation from GPC. This process makes it more exhaustive validating the data before assessing the Estimate to determine the contingency.

Another disadvantage of GAO that the author considers relevant is that it does not offer guidelines to contractors for preparing a bid using the same steps for estimating. This disadvantage makes GAO an incomplete process.

Despite that GPC has the elaboration of Cash flow in a different process map, but GPC Compendium and Reference has it in another process, this makes GPC a complete Process for Estimating and Budgeting.

Step 7

To monitor if GPC, GAO or TCM allow getting a good result, we can analyse different indicators as follows:

- Cost or time deviations during project execution of work packages do not exceed more than +5 % of a difference.
- A low number of change orders
- Few rebaselined schedules
- Contingency covers most of the risks identified.
- Risk Management Plan implemented efficiently
- Forecast based on contractor's performance produce a final cost which is within the range of the level of estimate chosen
- Most of the indicators or KPI suggested come from the EVM system.

CONCLUSIONS-

We have determined that the best process map for estimating and budgeting is the one suggested by the Guild of Project Controls.

Besides, we have identified the strengths of Guild of Project Control's Process Map for Estimating and Budgeting and a few relevant differentiators are:

- Owner and Contractor's perspective which produces an efficient interface between estimates, schedules and WBS.
- Bottom-Up and Top-Down Estimates



- Exhaustive validation of the estimate before assessment for calculating contingency.

Besides, we have identified some improvements that the author can suggest to TCM, GPC and GAO that we mentioned as weaknesses:

TCM

1. Processes do not contain a description of how to apply methods and tools. The Recommended Practices (RP) include this information, but each process does not mention which RP the reader must follow.

GPC

1. There must be a checklist after each process to facilitate auditing and to validate the use of each process and verify that everything applied correctly

GAO

1. To develop more the contractor's perspective, GAO could mention or use estimate's forms used in US Government platforms when gathering information from potential bidders or tenders.

In summary, the Guild of Project Controls offers almost a complete process for Estimating and Budgeting, putting a lot effort in integrating Owners and Contractors and also validating data before simulations to produce an optimum cost estimate that can be accurate, precise and reliable.

FOLLOW ON RESEARCH-

As explained before a good process not only should guide us to get an outcome that might comply with most investor's / owner's / portfolio's expectations. The final content also has to be the optimum result of a good process which flow allows the portfolio team to get the best alternative as final Estimate.

The analyse can be conducted through simulations, sensitivity analysis or risk analysis because most of these processes produce iterations to send the intermediate outcome to a process that requires a better or updated input.

It would be interesting to compare if the best process to estimating is better or has more strengths than 5D BIM which is the step to do a cost estimate.

That comparison would determine if 5D BIM maybe also meet most of the best practices in the project management sector for an optimum cost estimate.



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APPENDICES-

Appendix 1 – Content of Process Cost Estimating and Budgeting Map.

Scope, methods, deliverables and tools suggested by Total Cost Management, Guild of Project Control and Government Accounting Office:

OUTPUT	TCM	GPC	GAO
Plan	-Phased Oriented to obtain Authorization and Funding at each phase - Classes of Estimate - Scope Definition based on Project Size and Complexity - Identification of Roles and Responsibilities - Elaborate cost estimate and budgeting effort - Integrate contractor's information	- Phased Oriented - Estimate Levels linked to WBS Levels and Schedules Levels - Scope Definition based on Project Size and Complexity - Identification of Roles and Responsibilities - Elaborate cost estimate and budgeting effort - Integrate contractor's information - Owner's Perspective and Contractor's Perspective - Interfaces between Owner and Contractors	- Owner Perspective - Evaluation of Affordability and Performance - Support Selection of Alternatives and Solutions - Support Funding - Aligned with Missions, goal and strategic objectives - Tools and Techniques used Scope Definition - Expected Accuracy Ranges Linked to Size, Functionality and Complexity - Team to develop Estimate - Top Dow approach for estimating

OUTPUT	TCM	GPC	GAO
Estimate and Quantity Take-Off	- Elaboration of planning documents - Elaboration of technical documents - Elaboration of contract documents - Elaboration of database	- Involvement of the Project Management Team and major stakeholders for the development of a schedule - High-level summary level for sequencing and phasing the project - Validation of workflows between departments or different stakeholders - Elaboration of Standardised WBS and Control Accounts - Elaboration of RAM Matrix - Sources of Data - Assumptions and Constraints - Register of Major Changes among phases - Elaboration of Decision Support Packages - Selection of Cost Estimate Software - Level 1 and 2 of Cost Estimating for Owner - Value Analysis / Value Engineering for Owner - Budget, Authorization or Control for Owner - Owner Baseline, Owner Estimate, Bid or Tender Estimate - Contractor Scope of Work - Conduct Constructability Analysis - Value Analysis / Value Engineering for Contractor - Definition of final WBS and Accounts - Cost Estimate Templates for Contractors - Elaboration of Bill of Quantities - Elaboration of Contractor Cost Baseline, Bid or Tender	- Understanding of the acquisition program, acquisition strategy and Technical definition - System Design Features - Understanding of the technologies to be included in the design - Elaboration of Technical Baseline. It helps to identify specific technical and program risks. - Examples of System Characteristics and Parameters for government cost estimates, including military and civilian construction and information systems - Product-oriented WBS - Develop a Master WBS - Develop a WBS dictionary - Standardised WBS to collect and share data - A level of risk accompanies ground Rules and Assumptions, and project team communicates to Management - Definition of budget constraints - Choose of Estimating Methodology - Data contains technical, schedule or program and cost data. - Recommendations of Sources of Data - Contractors Proposal to validate because it is not always reliable - Data Applicability from other programs - Contract Types for Procurement - Data can support the application of EVM - Standardisation of data

OUTPUT	TCM	GPC	GAO
			- Recurring and Non-Recurring Costs - Inflation Adjustment - It contains formats for Data Documentation - Identification of Cost Drivers - Estimating Methods

OUTPUT	TCM	GPC	GAO
Estimate Validated		- Validation by Contractor and Owner of Schedule loaded with resource and cost before acceptance of CPM schedule as a baseline or rebaseline - Assumptions - Sensitivity Analysis of Assumptions - Montecarlo Simulation (for money) - Contingency (Buffer or Buried) - Management Reserve for Steering Committee - Schedule Optimization Analysis (Owner Cost, Contractor Cost and Total Cost) - Schedule Interfaces (external or internal) for Horizontal Traceability - WBS / CBS / Activity Coding Structure to communicate the same information from Owner to contractor	- GAO is a reference of GPC - Recommendation to validate against an independent cost estimate
Assessment of Estimate	- Evaluation through Value Analysis or Engineering. - Optimisation of scope through cost - Evaluation of cost risk	- Third control check before submission for approval as performance measurement baseline - Simulation includes contingencies - Brainstorming of risks. Risk Register - Ranges of Duration of Activities and probabilities of comfort level management - Use of Montecarlo Simulation (without constraints) - Revision of Network Logic Risk - Avoid merge bias or merge points - Schedule Cost Contingency approach (Buffer or Buried) - Risk prioritisation	- Sensitivity Analysis with the identification of cost drivers - Sensitivity Analysis gives you low and high values of the impact of only one change - Risk and Uncertainty evaluates multiple changes - Elaboration of Risk Register. - Preparation of Risk Matrix (Probability Impact Matrix) - Analysis at WBS cost element - Use of Montecarlo for simulation - Determine Level of Comfort of the Estimate - Calculate Contingency - Convert the estimate in Then-Year Dollars and Identify High-Risk Element - Creating a Risk Management Plan

OUTPUT	TCM	GPC	GAO
		- Probability Branching method	
Budget	- Allocate cost into project cost accounts for control - Budget is Time-Phased		
Cash flow	- Determine rates of investment and cash disbursement		
Documentation of Estimate. Baseline for control	- Compare it to historical information, similar past estimates or independent third party - Look for improvement opportunities - Should lead to a revision of previous steps	- Owner perspective to get approval and move to the next phase. - Contractor's perspective to get approval and get the Notice to Proceed - Elaboration of Basis of Estimate as part of the documentation for approval - PMB for Owner and Contractor are different - Schedule with Cost and Resource loaded approved as a baseline	- Elaboration of Basis of Estimate with narrative and cost tables - It addresses 12 steps of high-quality estimates
Approval of Estimate			- Elaboration of a briefing presentation for Management. a content is suggested to explain Scope, GR&As, WBS, Methods of estimating, Sensitivity and Risk Analysis, Contingency and Changes if they were necessary
Submission of Estimate for Tendering	- For contractors, bidding is the final process of Estimating - For owners, this bid is an input for the overall asset		



OUTPUT	TCM	GPC	GAO
Control of Estimate	- Creation of Database and Algorithm to develop estimates. - Information must be updated and also adapted to the enterprise situation. - Controlling baseline is part of another process.	- Updating CPM Schedule to know 1) what the project team achieved and 2) when the project team completed it - Methods for measuring progress. Decisions made on execution which is not 24hours old - Capture Time, Productivity, Materials, Manpower and Machinery progress and Data - "Today's productivity forms the basis for tomorrow's estimate - Capture Actual Cost of Work Performed - Report Status and Update the Schedule. Once Updated, the schedule should have a validation of the critical path, a validation of horizontal and vertical integration and schedule risk analysis. - Isolate Progress from Logic Changes - Earned Value Analysis - Perform Critical Path, Near-Critical Path, and Non-Critical Path Analysis - Root Causes Problems Identified - Validate new schedule with the project team and decide on crashing, fast-tracking and descoping activities, to validate new projected dates - Addition of new activities if necessary and how to report progress - Status Reports Submitted, Analysed and Published with Predictive, Proactive or Corrective Actions	- Implementation of the EVM system - Implementing Surveillance Organisation (independent organisation) - Incorporate changes in the new PMB - Update of EAC with continuous reports - Identification of problems and act quickly

Table 3 List of Tasks, Methods and Tools for each Process Map⁸

⁸ By Author

