
DOES BIM OFFER A BETTER APPROACH TO GUARANTEE A RELIABLE, ACCURATE, AND PRECISE COST ESTIMATE?

ABSTRACT-

Building Information Modeling (BIM) uses on Integrated Project Delivery (IPD) approach, a collaborative and participative method with stakeholders in early stages of the project; this should be a significant differentiator comparing with TCM, GPC, and GAO which use a traditional Project Delivery approach.

It is necessary at each stage to deliver a document or file with a level of detail according to the development of the model. 5D BIM is one of the deliverables that contains the cost of the resources required to execute the activities and install or produce the project quantities for each component of the model.

Has BIM a better process to define the scope and produce a better cost Estimate than a traditional method for estimating and budgeting?

Can BIM offer a better approach to guarantee a reliable, accurate, and precise cost Estimate?

The current document will:

- Determine if the participation in the early stages of the design process might help to define the scope and then produce a better cost Estimate.
- That IPD approach is better than a traditional approach.
- To determine that 5D BIM is a reliable, accurate, and precise outcome.

KEYWORDS- Cost Estimate, Budgeting, Project Estimates, Building Information Modelling, 5D BIM, Integrated Project Delivery, Front-End Loading.



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"Best Tested and Proven Practice" ☐

New or Academic Theory ☒

Process or Procedure (New or Improved) ☐

Other _____ ☐



INTRODUCTION-

Most of the companies worldwide have adopted the traditional approach for acquiring, created, update, maintain, expand and eventually dispose of organisational assets that consist on the gate approach where the sequential planning that has inputs, activities, deliverables, closing activities, and milestones on early stages that result in the success of the project.

A traditional planning approach defines the activities to do the work and also predicts what the time should take, and the cost should be to complete these activities. This Front End Development approach should begin before the engineering design /EPC phase.

The academic community and the private industry have evidenced that the most critical decisions are made by the business decision-makers long before the design and construction stages start. For example, Independent Project Analysis, Inc. (IPA), Construction Industry Institute (CII), Shell, Anglo-American Mining, Saudi Aramco, and Chevron are part of organizations which have evidenced this idea.

The following figure shows different stage-gating processes for the planning approach.

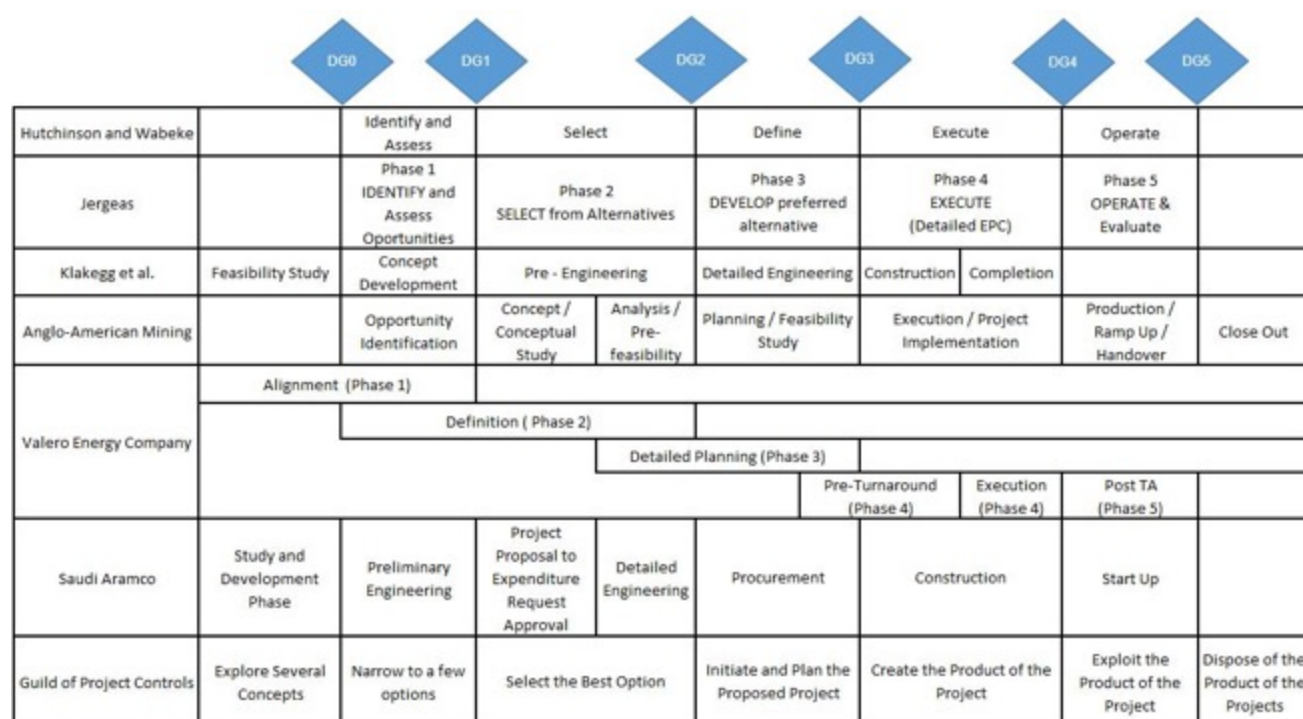


Figure 1 Multi-Stages for Decision Gate Approach¹

¹ By Author

Besides, there are other approaches to assess the effort to plan. The most known processes are Front-End Loading (FEL) and Project Definition Rating Index (PDRI).

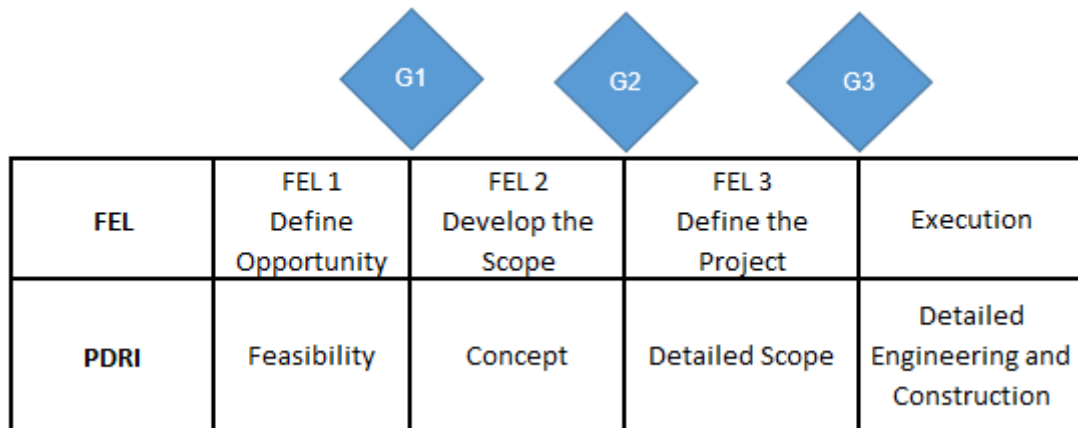


Figure 2 Front End Loading (FEL) and Project Definition Rate Index (PDRI) processes²

Despite the implementation of several Front End Development approaches, projects still have cost overruns.

Most factors of overruns are wrong Estimates, poor project definition; the initial BOE did not include final costs incurred, unsettle requirements during quotation phase, Project Complexity, Type of Ownership, and other factors.

What are the factors that influence in a Wrong Estimate?

- Poor scope definition.
- Estimates are biased with over-optimism.
- Inaccurate initial Estimates contain overall cost and schedule. It reflects technology development to accomplish the original work scope.
- Ratios and Unit Prices require to be updated
- Estimates changes with the phase of the development of the asset
- Escalation indexes do not reflect actual costs
- Unexperienced Estimator
- Bad calculation of Contingency or
- A contingency is not allowed.

Why do project teams obtain a poor scope definition?

² By Author

Most of the cases, according to Glen Butts from NASA, there is an Omission of scope that becomes real and unrealistic or optimistic assumptions.

According to MacLeamy, the implementation of changes in the first stages of the project regarding the scope of the project has a low-cost impact. The MacLeamy curve shows how the effect of changes influences the cost of those implementations, notably, in the early stages of a project.

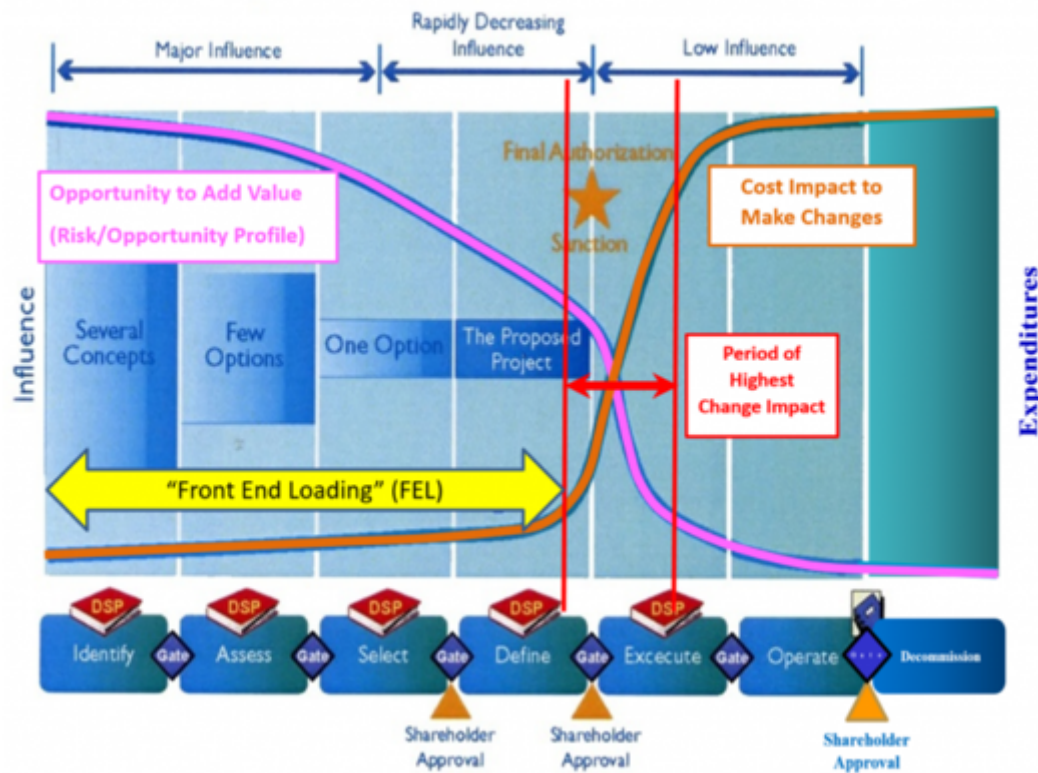


Figure 3 MacLeamy Curve with Front End Loading process³

Integrated Project Delivery is a concept from The American Institute of Architects (AIA) which intends to improve the interaction among stakeholders, systems, business structures, and practices into a process that improves collaboration among owners, contractors, and designers. Also, it helps to reduce waste and improve efficiency during all phases of design, fabrication, construction and decommissioning.

It suggests moving decisions upstream where they are more effective and less costly, as shown in Figure 4. This redefinition of phases has two key aspects: the early involvement with inputs from contractors, installers, fabricators, and suppliers; and also designers; and the ability to model and simulate the project

³ Guild of Project Controls. (2015, December 10). 10.3 Managing Change the Owner's Perspective Rev 1.01. Page 7 Retrieved September 15, 2018, from <http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective>

using BIM tools. The result is a design with a high level of completion before the documentation for construction starts.

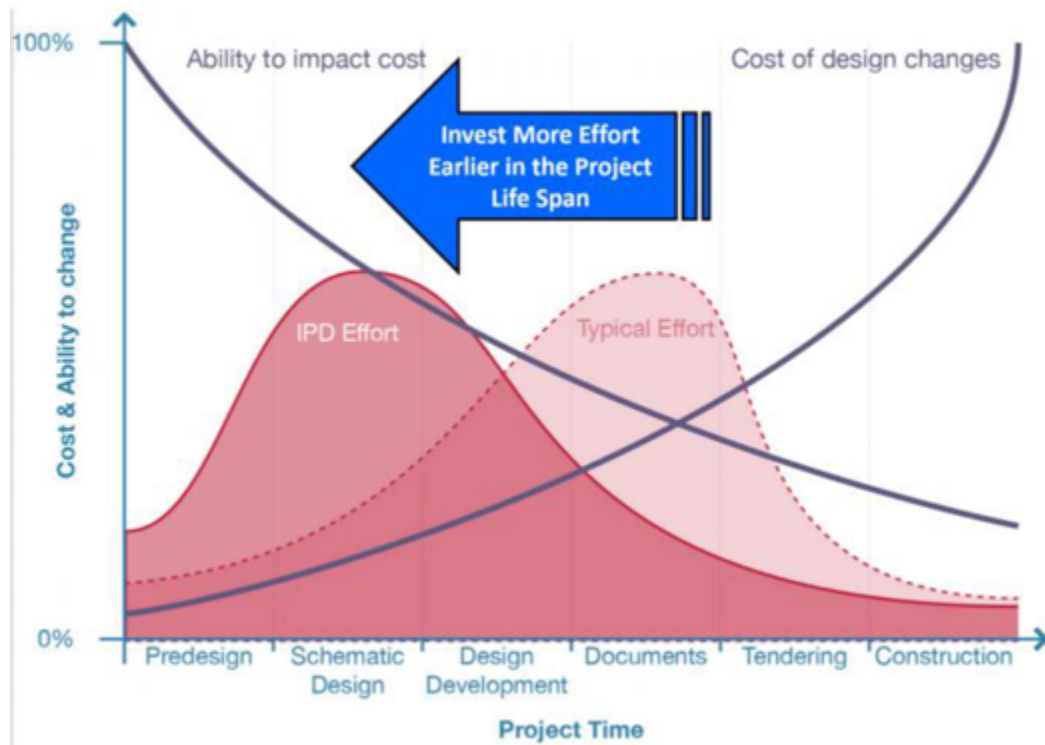


Figure 4 Left Shift of Front End Loading⁴

Building Information Modelling (BIM) has adopted this concept to implement these processes and involve in early stages all the stakeholders under collaborative platforms to improve collaboration, communication, and coordination among all participants.

BIM has had an impact on:

1. Professionals, Projects, Firms, and Industries
2. Involvement of Major Stakeholders in the life cycle of the project
3. The operating system of the project environment. E.g., Technology, Work Practices, Processes, Legal, Commercial.
4. Project Delivery. It affects all the processes.

⁴ Guild of Project Controls. (2015, December 10). 10.3 Managing Change the Owner's Perspective Rev 1.01. Page 4 Retrieved September 15, 2018, from <http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective>

The benefits of BIM are listed but not limited to:

1. Improvements of overlaps among design, construction, and operations.
2. Enhance analytic power of risk, procurement, and asset management functions.
3. Reduction of waste. A more sustainable environment.
4. Enhance collaboration, coordination, and communication
5. Information can be anywhere at any time.
6. Product-oriented. It is more relevant knowledge than skills
7. Facility Management process is more integrated and automated
8. Optimization of Procurement and Contracts activities
9. Standardization of methods and systems to increase profitability
10. Facilitator of new technologies such as digital fabrication, cloud computing, big data, and other tools.
11. Smart cities concept
12. Create new business opportunities

BIM covers different stages of the life cycle of an asset. Companies require to reach a maturity level for implementing BIM, not only to design the 3D model but also for collecting, for coordinating and for communicating all the information to all stakeholders during the life cycle of the asset.

It is necessary at each stage to deliver a document or file with a level of detail according to the development of the model. 5D is one of the deliverables that contains the cost of the resources required to execute the activities and install or produce the project quantities for each component of the model.

Most of the Estimates use the traditional approach for estimating and budgeting.

Has BIM a better process to define the scope and produce a better cost Estimate than a traditional method for estimating and budgeting?

Can BIM offer a better approach to guarantee a reliable, accurate, and precise cost Estimate?

The current document will:

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METHODOLOGY-

Step 1

Building Information Modeling is a method that not only develops a 3D model. It uses the data elaborated to communicate, collaborate, and interact among different stakeholders during design, construction, operation, and decommissioning stages. Building projects and nonbuilding projects use this method. During the development of the model before construction, it elaborates a budget or 5D BIM outcome.

According to the method, companies that implement BIM need to modify the traditional process to build a model, to consolidate information, to share data, and to manage the interfaces among stakeholders. It depends on the level of maturity of the BIM method.

Is the process for Estimating and Budgeting to obtain a 5D BIM outcome better than a traditional one? What are the advantages of developing a Cost Estimate with BIM?

Step 2

The following entities suggest different Estimating and Budgeting Process Maps:

1. Guild of Project Controls has the following process map:

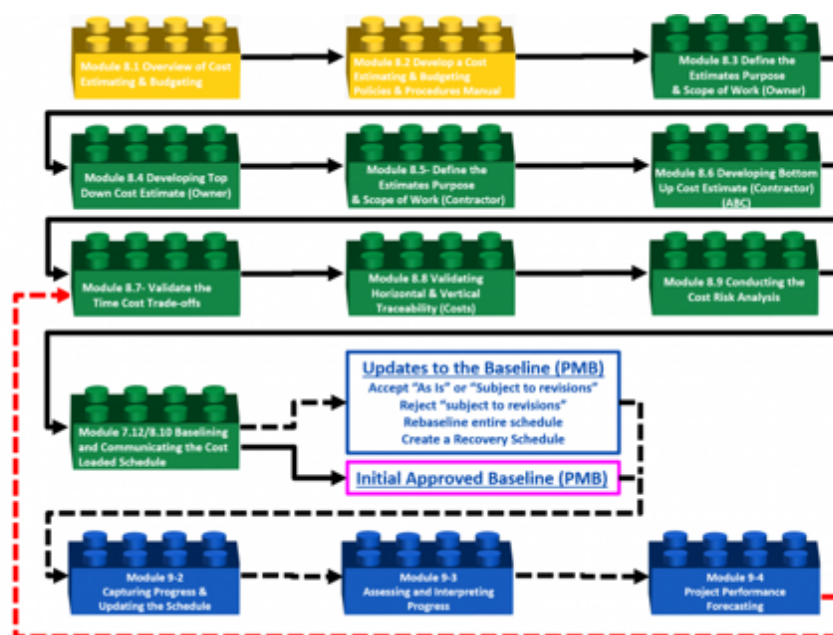


Figure 5 Process Flow Chart for Estimating and Budgeting⁵

⁵ 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>

2. AACE International in Total Cost Management Framework recommends the following process map:

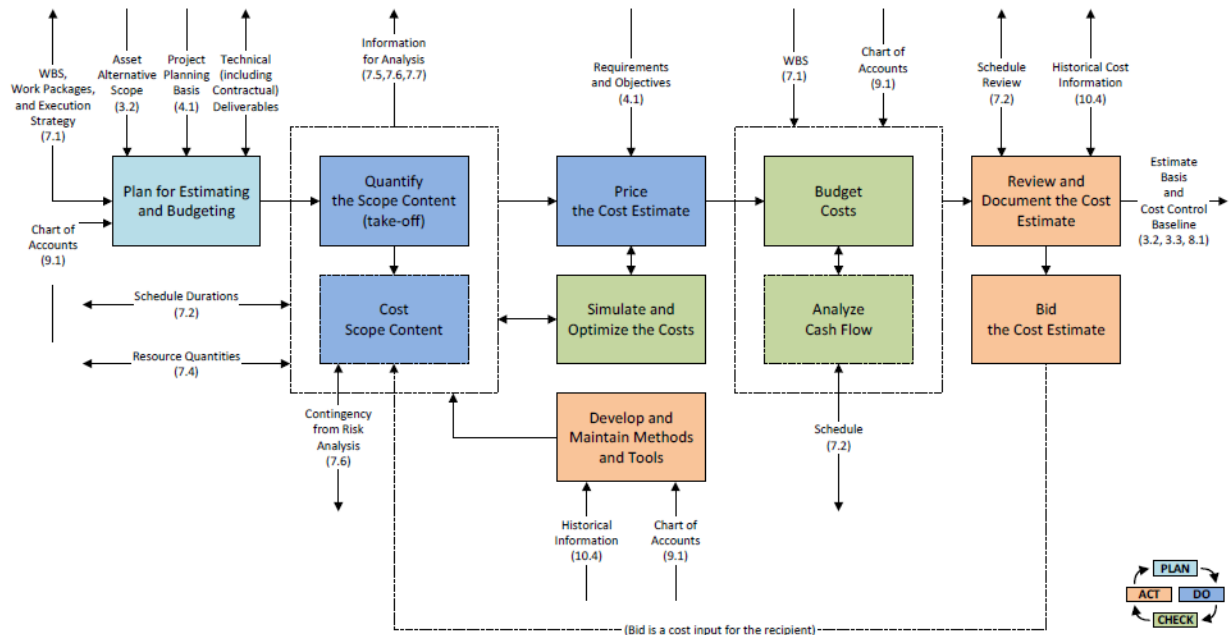
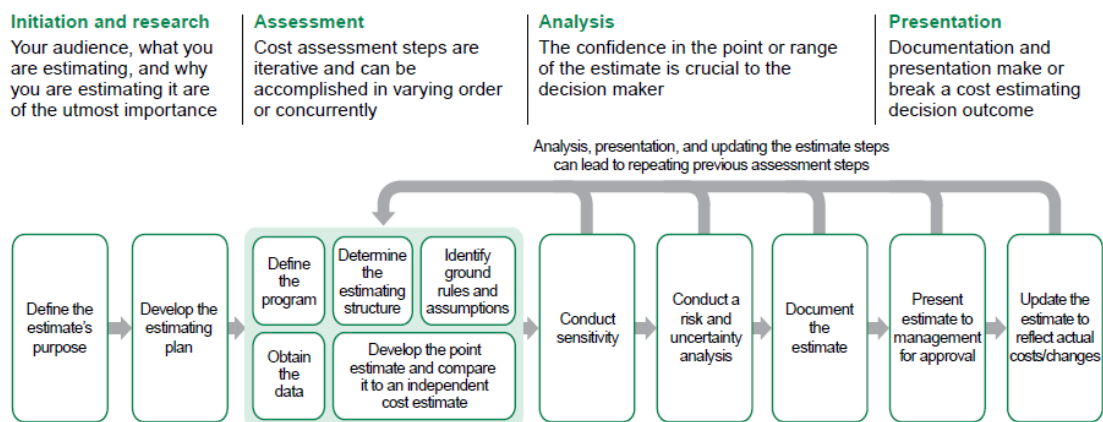


Figure 6 Process Map for Cost Estimating and Budgeting⁶

3. Government Accountability Office suggests the following Cost Estimating Process:



⁶ H. Lance Stephenson. (2015). Total cost management framework: An Integrated Approach to Portfolio, Program, and Project Management (2nd ed.). Morgantown, WV: AACE International. Page 176

Figure 7 Cost Estimating Process⁷

4. Building Information Modelling or BIM is a method that uses technology, improve work practices and processes, for the construction of any building and nonbuilding project. The following figure shows different stages of the life cycle of an asset.

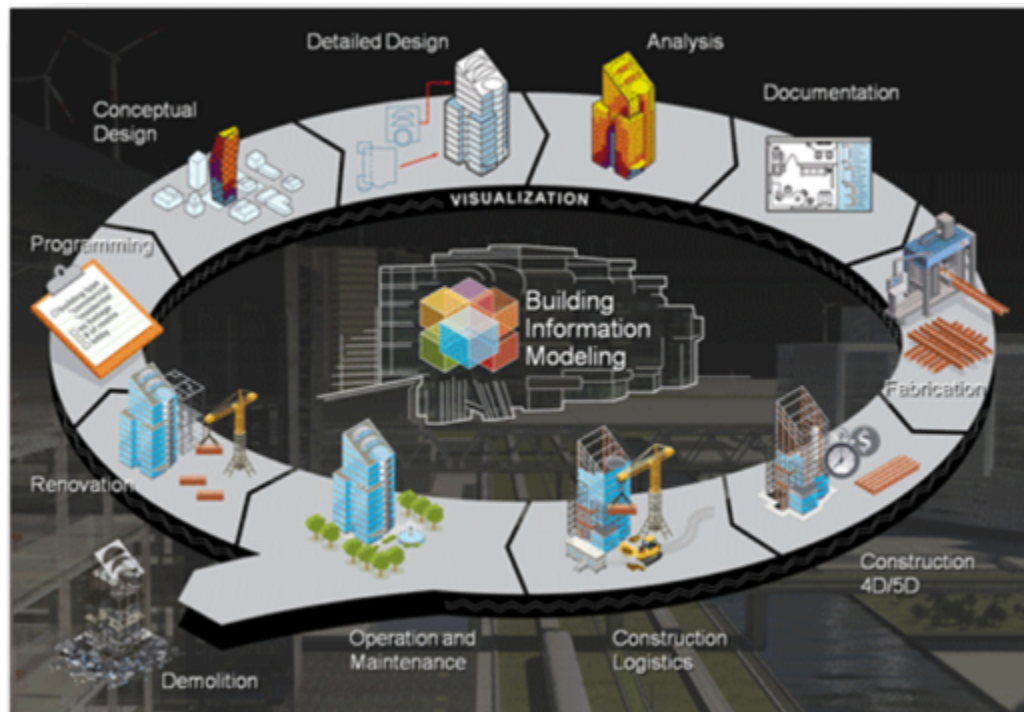


Figure 8 BIM Workflow⁸

All companies require to reach a maturity level for implementing BIM. It not only produces 3D models but also gathers, coordinates, and communicates all the information in a Common Data Environment (CDE) with all stakeholders through the life cycle of the asset. The goal is to reach level two and three of maturity, as observed in the following figure:

⁷ GAO Cost Estimating and Assessment Guide- Best Practices for Developing and Managing Capital Program Costs. Page 8

⁸ The BIM hub. (2015, April 8). #BIM: Bringing a 'sea change to the industry's workflow?. Retrieved April 23, 2019, from <https://thebimhub.com/2015/04/08/bim-bringing-a-sea-change-to-the-industrys-workflo>

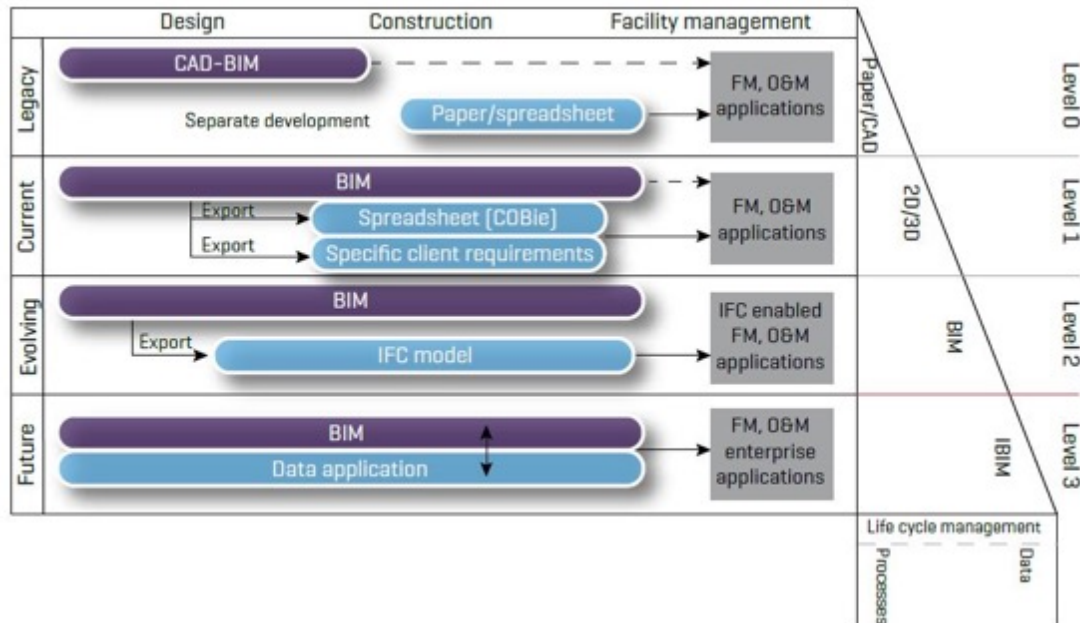


Figure 9 Facility Manager and Maturity Levels from Bew and Richards⁹

Several institutes have elaborated execution plans for BIM to promote best practices. They include the following:

- I. Goals to set expectation levels for all stakeholders
- II. Roles and responsibilities for all project team members
- III. An overall BIM strategy, including procurement and project delivery
- IV. A BIM process and exchange protocols for all team members
- V. Data requirements at different stages of the project
- VI. Elaboration of procedures for collaboration and methods to handle shared models
- VII. Quality control of models; and
- VIII. Technology infrastructure and software required for implementation.

Some execution plans are listed below:

1. Penn State University's BIM execution planning guide version 2.0
2. The US Department of Veterans Affairs - The VA BIM guide
3. The Building and Construction Authority from Singapore - BIM guide: version 2.0
4. CPIx (UK) - BIM execution plan

⁹ Royal Institution of Chartered Surveyors (RICS). (2016, November 4). International BIM Implementation Guide, 1st edition. Page 62. Retrieved January 5, 2019, from <https://www.rics.org/latin-america/upholding-professional-standards/sector-standards/construction/international-bim-implementation-guide/>

5. BIM protocol by the CIC (Construction Institute Council)/BIM Pro)

A Digital Plan of Work is attached to those plans such as:

1. Royal Institute of British Architects (RIBA) - Plan of work 2013.
2. BIM task group. Digital Plan of Work (PAS 1192-2).
3. Building Information Modelling from AIA and Digital Data Exhibits.
4. Digital Plan of Work from the UK Government.

Also, these plans help to define the key objectives, BIM activities, type of model, and the level of development (LOD) to obtain the following:

- I. To elaborate a conceptual design or a planning stage of a project
- II. To analyze and to enhance the profitability of the project looking for efficiencies in time, cost and sustainability-related
- III. To manage documentation, procurement and pre-construction planning activities
- IV. To conduct the construction process and commissioning
- V. To support the operation and maintenance phase
- VI. Also to retrofit and demolition

The following figure shows an information delivery cycle from BSI - PAS 1192-2:



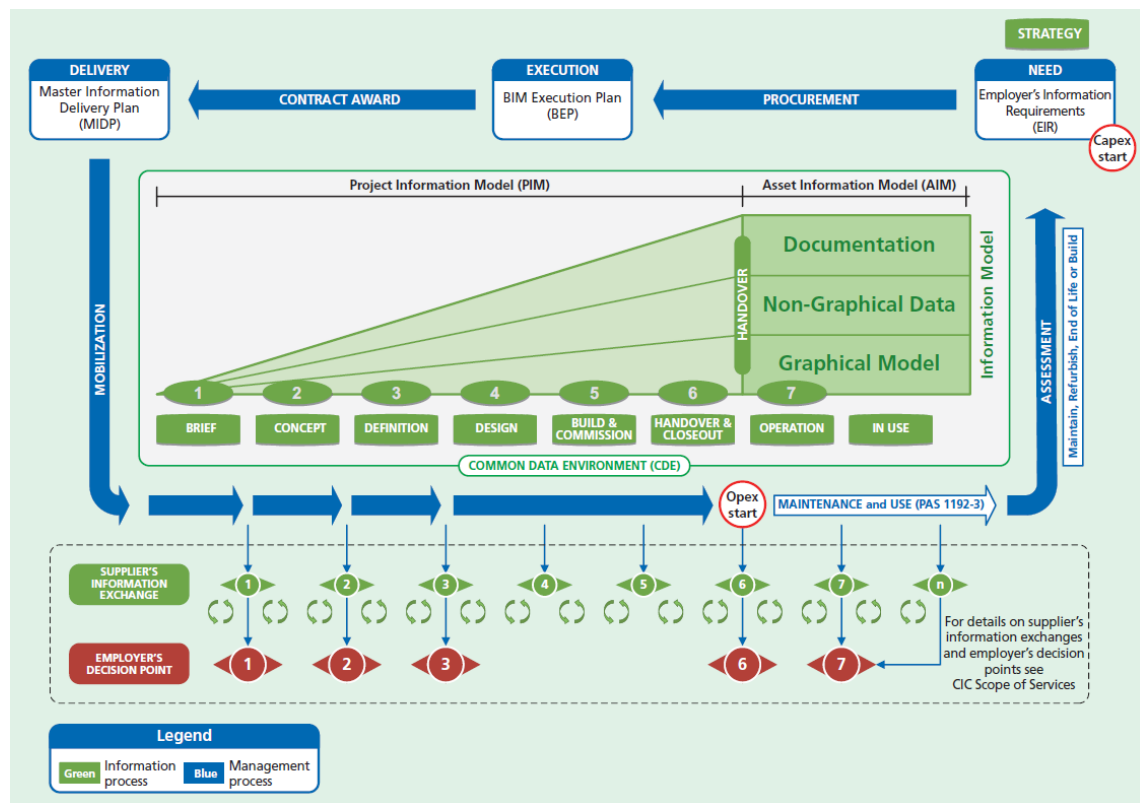
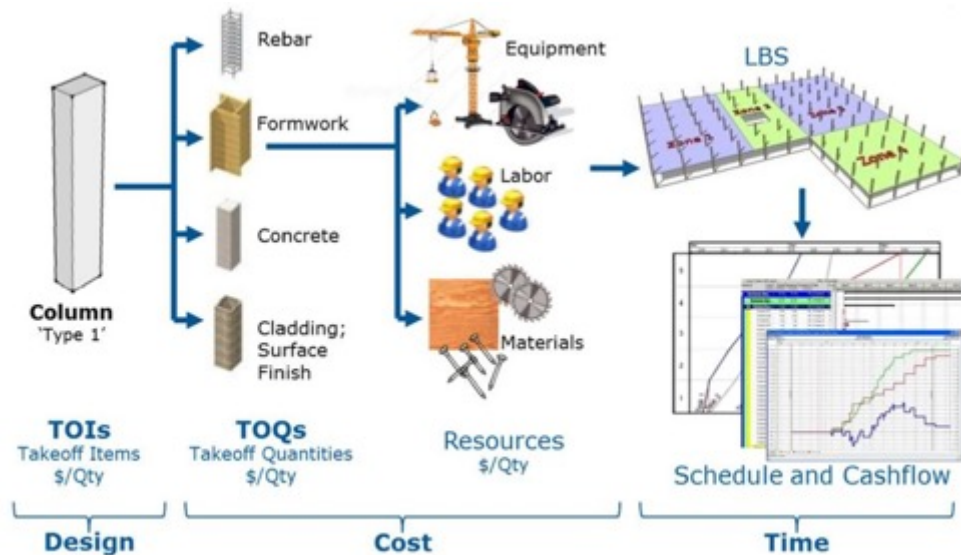


Figure 10 Information delivery cycle¹⁰

The information is under a Common Data Environment (CDE) through the phases of asset development. There is a simple workflow for a project cost Estimate that summarises all the process:

¹⁰ British Standard Institution. (2013, March 28). Publicly Available Specifications (PAS) 1192-2. Standards | BIM Level 2. Page 8 .Retrieved January 5, 2019, from <https://bim-level2.org/standards>

Figure 11 5D Workflow¹¹

This simple workflow applies to each phase; what is different is the Level of Development (LOD) of the model required for each stage.

Step 3

GPC has the following list of processes to elaborate a project Cost Estimate:

1. GPC
 - Cost Estimating and Budgeting Overview
 - Elaborate a Cost Estimating and Budgeting Policies and Procedures Manual
 - Describe the Estimate Purpose and Scope of Work (Owner)
 - Establish a Top-Down Cost Estimate (Owner)
 - Describe the Estimates Purpose and Scope of Work (Contractor)
 - Elaborating Bottom-Up Project Estimate (Contractor) (ABC)

¹¹ Trimble Vico Office. (2011, March 8). The Vico Office 5D BIM Workflow.wmv [Video file]. Retrieved from https://www.youtube.com/watch?v=gdacRTap5_Y

- Validation of the Trade-Offs
- Validation of Traceability of Costs (Horizontal and Vertical)
- Elaboration of a Cost Risk Analysis
- Baseline and Communication of the Loaded Cost Schedule
- Capturing Progress and Updating Schedule
- Assessing Progress
- Forecast of Project Performance

2. AACE International - Total Cost Management

- Elaboration of Estimating and Budgeting Plan
- Quantification of the Scope (take-off)
- Adding Cost to Scope
- Pricing the Project Estimate
- Simulation and Optimization of the Estimate
- Budgeting Project Estimate
- Analyzing Cash Flow
- Revision and Documentation of the Estimate
- Bidding the Final Project Cost Estimate
- Elaborate Methods and Tools

3. GAO

- Describe Estimate Purpose
- Establish Estimating plan
- Describe program characteristics

