BIM

BUILDING INFORMATION MODELING

PLANNING GUIDE FOR FACILITY OWNERS

A buildingSMART alliance™ Project

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Executive Summary

This Guide presents a standard approach for facility owners to more effectively plan the integration of BIM throughout the organization and the lifecycle of a facility. Through effective BIM planning, owners can develop a clear business case to maximize the value of BIM implementation to support their facilities throughout their lifecycle.

Many readers of this guide may be familiar with the content of the BIM Project Execution Planning Guide[1]. That Guide focused on a strategy for maximizing the value of BIM implementation at a project level. This Guide takes a different perspective, and is specifically focused upon an organizational level of BIM planning for facility owners. When developing the organizational plans several levels of development were found to be beneficial. This Guide defines procedures to develop strategic, organizational execution, and procurement level plans. Each procedure requires an analysis of the planning elements from a variety of levels of detail and perspectives. To supplement the previously available BIM Project Execution Plan, this Guide provides three additional planning procedures (shown in Figure 0-1) to allow for the development of a cohesive strategy for the implementation of BIM. The entire set of planning procedures includes:

- **BIM Organizational Strategic Planning** to assess existing organizational conditions, align BIM goals and vision, and develop a transition plan to implement BIM;
- **BIM Organizational Execution Planning** to plan the detailed implementation within the operations of the organization;
- **BIM Project Procurement Planning** to identify key contractual issues to consider when creating contract requirements and a standard BIM Project Execution Plan template; and
- **BIM Project Execution Planning** (in BIM Project Execution Planning Guide) for project teams to maximize the value of BIM on a facility construction project (see the BIM Project Execution Planning Guide for additional details).

Figure 0-1: The BIM Planning Procedures

[1] Computer Integrated Construction Research Program, *BIM Project Execution Planning Guide - Version 2.1* (University Park, PA, USA: The Pennsylvania State University, 2011), http://bim.psu.edu.

Within the BIM planning procedure, common BIM Planning Elements exist that should be addressed. These BIM Planning Elements, shown in Figure 0-2, are classified into six categories including:

1. **Strategy:** The mission, vision, goals, and objectives, along with management support, BIM champions, and BIM planning committee.
2. **Uses:** The specific strategies of implementing BIM, including those BIM Uses for generating, processing, communicating, executing, and managing facility information.
3. **Process:** The means and methods by which the BIM Uses are accomplished, including understanding current processes, designing new BIM processes and developing transition processes.
4. **Information:** The facility informational needs of the organization, including the model element breakdown, level of development, and facility data.
5. **Infrastructure:** The resources needed to support BIM implementation, including software, hardware, and workspaces
6. **Personnel:** The effects of BIM on the personnel, including the roles and responsibilities, the structure or hierarchy, the education and training programs, and change readiness.

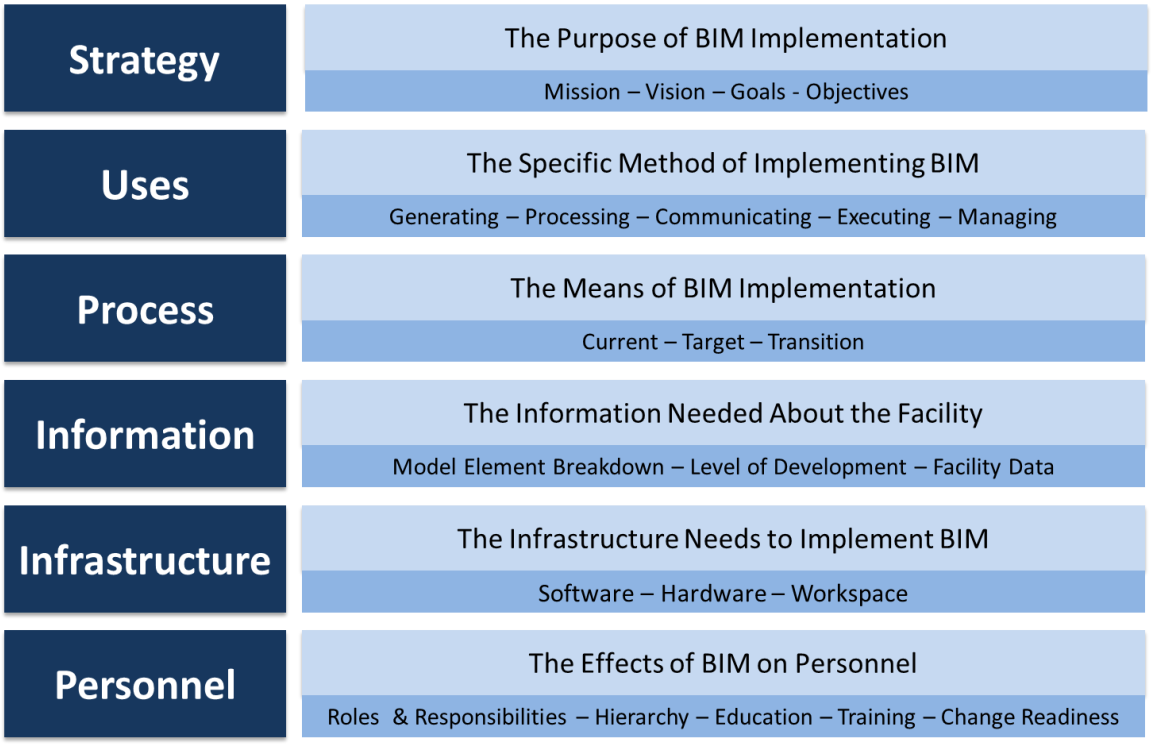

Figure 0-2: The BIM Planning Elements

The planning procedures and elements were created through a rigorous methodology including content analysis of available industry and research documents; industry interviews; workshops; and observational case studies. Prior to public dissemination, the BIM Planning Guide for Facility Owners has been reviewed by an expert advisory board, but it is important to note that this initial version of the guide is being release for industry comment. After publication, the Guide's principles will undergo validation through expert review, quasi-experiments, surveys, and implementation case studies. The goal of this Guide is to provide methods to facilitate more effective planning of BIM through standardized approaches, which will not only lead to more successful facility delivery, but also more effective facilities maintenance and operation throughout the entire lifecycle.

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Reader's Guide

The BIM Planning Guide for Facility Owners is directed toward readers with a fundamental understanding of BIM concepts. The intended audience of this Guide is facility owners along with designers, contractors, operators, and consultants who advise owners. While the Guide is written for facility owners who operate and maintain facilities, it can also provide value to those owners who procure facilities as well as other non-owner organizations wishing to adopt Building Information Modeling.

The Guide is separated into five primary sections. The first section provides an overview of the adoption concepts for an owner. The next three sections define three specific procedures or methods that can be implemented by an owner to develop their BIM plans. These include:

- A procedure for creating an Owner Organizational Strategic Plan (Section Two)
- A procedure for creating a detailed Owner Organizational Execution Plan (Section Three)
- A procedure for developing an project procurement language and a BIM project execution plan template (Section Four)

The Guide also contains a section on concluding remarks in Section Five.

Each chapter is written to stand-alone since they will be implemented by different teams and at different times. Therefore, some concepts are discussing several times throughout the document.

The appendices provide additional resources for implementing the procedures documented in this Guide. Electronic resources are also available at the project website (http://bim.psu.edu). These resources include Microsoft Word documents, Microsoft Excel spreadsheets for various template files, a Microsoft Visio file with template process models, and template forms for completing planning activities. The personnel responsible for BIM planning can use these documents to develop a Strategic Plan, Organizational Execution Plan, and Procurement Plan and Documents.

Throughout the guide, case study examples are provided as illustration of the content discussed. Those examples were developed from case study analysis.

It is important to note that this Guide has been developed through a research project focused on creating standard methods that can be used by facility owners to plan for BIM implementation. This version, version 1.0, of the Guide is a starting point. Over the next year, the research team will be working with owners to implement and test the procedures documented through the research. The Guide is provided as a resource *prior to* detailed testing. Revisions and additional case study results will be added to future versions of the Guide. Any feedback regarding this Guide or the template documents should be directed to John Messner at jmessner@engr.psu.edu.

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1 Introduction to BIM Planning for Owners

In 2009, the Building Information Modeling (BIM) Project Execution Planning Guide[2] was released. That Guide documented a planning procedure for BIM execution on facility projects, and it outlined a philosophy to 'Begin with the End in Mind' when planning BIM implementation on a project. This philosophy highlighted the need for facility owners to understand and communicate their goals and procedures for implementing BIM throughout the lifecycle of the facility so that teams could support their information requirements. When the planning guide was released, few owners had outlined their BIM strategy for implementation – both within the operations of their facilities and within the design and construction process. Therefore, a need was identified to assist owners in the development of a clear vision, strategy, and execution plan for implementing BIM within their organizations to maximize the value of BIM.

Research has shown the value of implementing BIM on projects throughout various stages of a project. Significant value can be achieved through the implementation of BIM to develop and analyze facility designs. Projects can also gain advantages through the rapid development of cost estimates, and the use of 4D models for visualizing construction sequence. And the industry is just now starting to see interesting examples of owners leveraging the value of BIM in the facility maintenance and operations phase of the facility lifecycle.

To achieve the maximum benefit from BIM implementation, it is important for the information is developed from a guiding set of core value propositions which align with an owner's purpose and mission. This value proposition should be defined through the development of a BIM Organizational Strategic Plan. This Strategic Plan can direct the development of a more detailed BIM Organizational Execution Plan, which focuses on detailed planning concepts related to BIM uses, process, personnel, and other infrastructure. The owner will also benefit from developing a BIM Project Procurement Plan to direct the purchasing and procurement decisions for services provides that perform BIM services throughout the various phases of project. These plans will all feed into the BIM Project Execution Plans when performing facility design and construction projects (see Figure 1-1).

Figure 1-1: BIM Planning for an Owner Organization

[2] Computer Integrated Construction Research Program, *BIM Project Execution Planning Guide - Version 2.1*.

1.1 What is Building Information Modeling?

Prior to discussing the planning procedures for BIM, it is important to discuss the breadth of the Guide's view of Building Information Modeling. For the purposes of developing this guide and the planning procedures, the definition of BIM used is as presented within the U.S. National Building Information Modeling Standards (NBIMS-US) which defines BIM as *the act of creating an electronic model of a facility for the purpose of visualization, engineering analysis, conflict, analysis, code criteria checking, cost engineering, as-built product, budgeting and many other purposes…*[3]

1.2 Importance of BIM for Owners

BIM is clearly gaining adoption within the design and construction processes for delivering facilities. Firms are shifting their standard practices toward the use of intelligent, 3D models which can be more easily modified, and which accurately represent the final building product. Nevertheless, BIM is not just useful in the design and construction process. Owners can benefit from the use of BIM for developing higher quality building models with information that supports the lifecycle of the facility.

The information that is generated within the delivery process, or through subsequent modeling activities, can be leveraged to improve the overall operations and maintenance of the facility. For example, with well-defined information exchange processes and after appropriate quality control tasks, an owner can automate the entry of as-built data and information into their Facility Management System (FMS). Model information can also be used to support future renovations, and to run ongoing analyses of the operational capabilities of the facility. While these benefits can be difficult to measure at times, it is clear that BIM can provide significant benefits to an owner.

According to the 2009 Smart Market Report, owners are likely to see a high return on investment in BIM. According to the report, a large majority of owners believe that BIM use is expanding and the owners are driving this change. Some owners are currently using BIM to help improve project cost, project speed, and facility quality[4]. Currently the primary benefits of BIM for owners are better communication, lower project costs, avoiding rework, better project outcomes, and better performing buildings. In 2007, Stanford University's Center for Integrated Facilities Engineering showed that BIM provided a 40% reduction of unbudgeted changes; provided cost estimates within 3% of the traditional estimates; contract savings of up to 10% with the use of clash detection; and reduced project time by up to 7%.[5] While most of these benefits are gained during the design construction phases, it is the hope that this Guide helps owners realize the benefits of BIM throughout the entire facility lifecycle.

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[3] buildingSMART alliance, *National Building Information Modeling Standard Version 1 - Part 1: Overview, Principles, and Methodologies* (National Institute of Building Sciences, 2007).
[4] Norbert Young et al., *THE BUSINESS VALUE OF BIM: Getting Building Information Modeling to the Bottom Line,* Smart Market Report (New York, NY: McGraw Hill Construction, 2009), www.bim.construction.com.
[5] B. Gilligan and J. Kunz, "VDC Use in 2007: Significant Value, Dramatic Growth, and Apparent Business Opportunity," *Center for Integrated Facility Engineering, Report #TR171* (December 2007).

1.3 Building Information Modeling Organizational Strategic Planning

When an organization first begins to integrate Building Information Modeling, they should consider it from strategic level to determine how BIM will integrate within the organization. The BIM Organizational Strategic Planning Procedure provides steps that an owner organization can use to plan for BIM at a strategic level. The goal of the planning procedure is to allow an owner to determine its purpose and vision for the integration of BIM within the organization. BIM Organizational Strategic Planning Procedure, as shown in Figure 1-2, for BIM includes:

1. Assessing the organization's internal and external BIM status;
2. Aligning the organization's BIM objectives by identifying its desired level of maturity; and
3. Advancing the BIM maturity level through developing a defined advancement strategy.

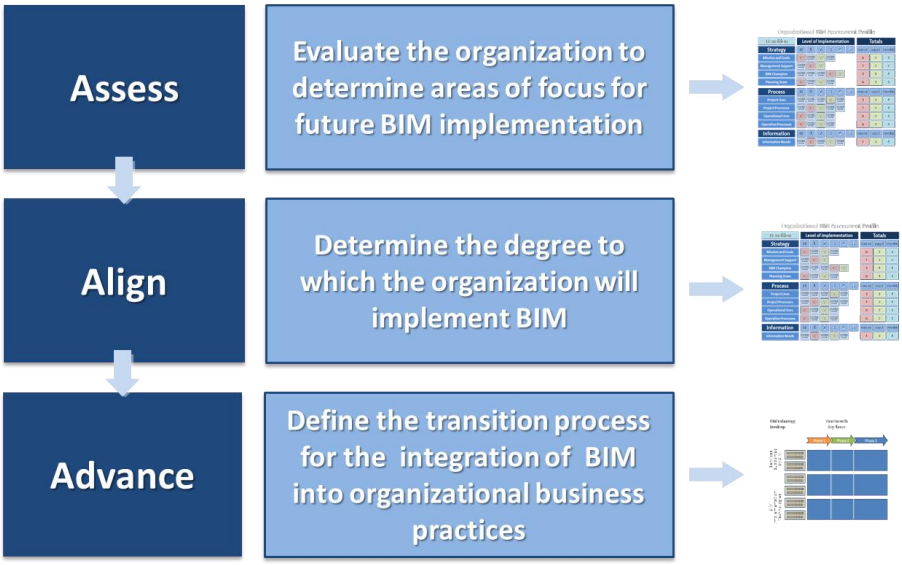


Figure 1-2: Strategic Planning Procedure for BIM

1.4 Owner BIM Organizational Execution Planning Procedure

After the BIM Organizational Strategic Plan has been developed, an Owner BIM Organizational Execution Plan can be created. The purpose of this plan is to determine and document the detailed blueprint for implementation to achieve the next stage in the organization's BIM development. These needs and the steps of the Owner BIM Organizational Execution Planning Procedure shown in Figure 1-3, include:

1. Evaluating Strategy;
2. Determining BIM Uses;
3. Mapping Processes;
4. Documenting Information Requirements;
5. Determining Infrastructure Needs; and
6. Defining Personnel Requirements.

When creating an Owner BIM Organizational Execution Plan, the organization should only focus on the Uses of Building Information Modeling that will be performed internally by the organization itself. Additionally, the duration of the Owner BIM Organizational Execution Plan should align with the phases depicted in the BIM Organizational Strategic Plan.

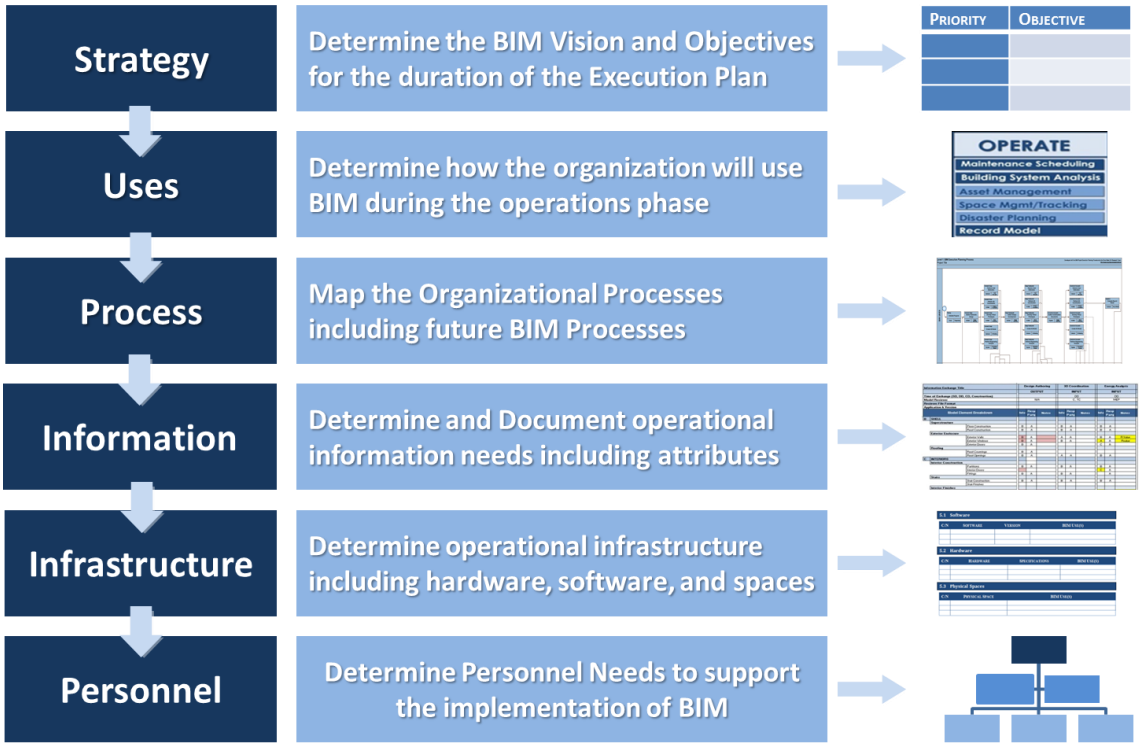


Figure 1-3: The Organizational BIM Execution Planning Procedure

1.5 Owner BIM Project Procurement Planning Procedure

Prior to the start of a new project, an owner should develop the front-end BIM documentation. This language is necessary to ensure that all of the owner's BIM needs are met, and the entire project team understands the requirements to which they are agreeing. With the proper documentation in place at the beginning of the project, the team can begin the BIM process much earlier and effectively. The front-end documents where BIM language must be included are:

1. Request for Qualifications (RFQ);
2. Request for Proposal (RFP);
3. Contract Requirements; and
4. Standard BIM Project Execution Plan Template.

With an adequate RFQ and RFP, a project team with the skills necessary to comply with the BIM Contract Requirements and BIM Project Execution Plan can be selected – setting the foundation for a successful BIM implementation on a project. As Figure 1-4 shows, the contract requirements and the BIM Project Execution Plan Template should work closely together, referencing each other in an effort to minimize duplication and inconsistencies between the two documents.

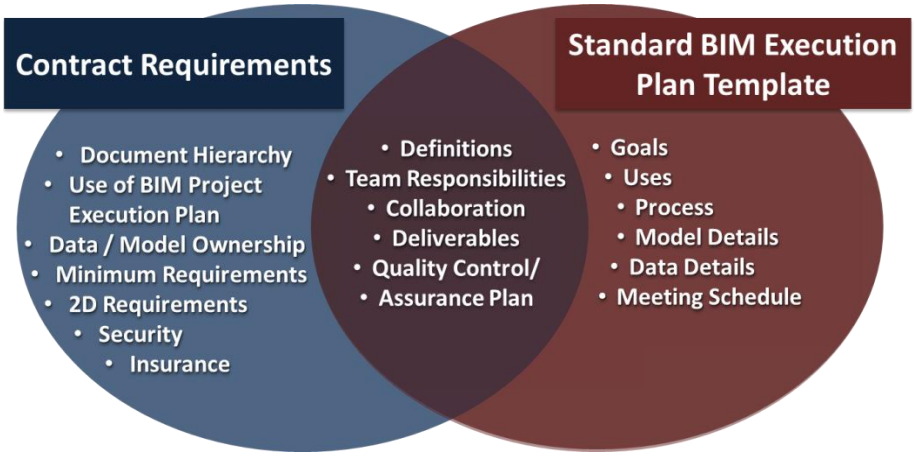


Figure 1-4: BIM Contract Requirements and Standard BIM Project Execution Plan Template Features

With a quality project team selected through the RFQ/RFP process, and the Contract Requirements and BIM Project Execution Plan working in tandem, an owner is more likely to implement BIM successfully on new projects.

1.6 The BIM Planning Elements

Throughout all BIM Planning procedures serveral core elements, at differing levels of complexity, repeat themselves. These core elements are refered to as BIM Planning Elements. Figure 1-5 shows a diagram of the BIM Planning Elements.

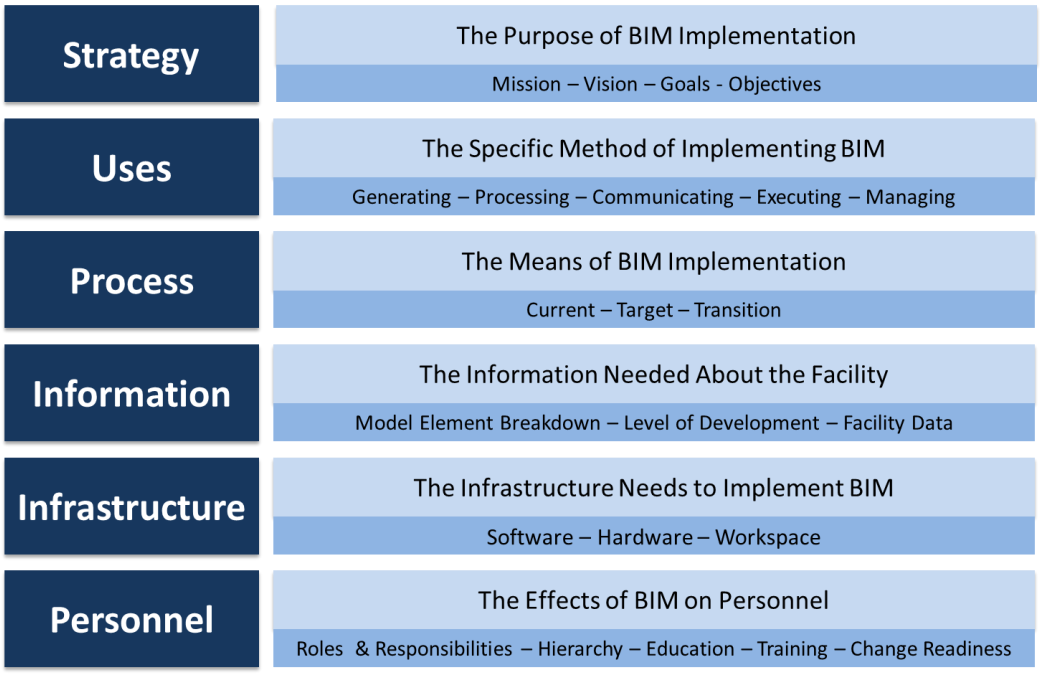


Figure 1-5: The BIM Planning Elements

Strategy: The planning elements related to the overall BIM Strategy including mission, vision, goals, and objective; management and resource support, BIM Champion(s) and BIM planning committee

BIM Uses: During each aspect of planning the specific methods in which BIM will be implemented, or BIM Uses, need to be considered. This includes BIM Uses for generating, processing, communicating, executing, and managing information about the facility

Process: The means and methods to accomplish the BIM Uses, including documenting the current processes, designing new BIM processes and developing transition processes.

Information: The facility informational needs of the organization, including the model element breakdown, level of development, and facility data. Those elements related to the facility data needs of the organization, including model element breakdown, level of development, and facility data.

Infrastructure: The elements needed to support a BIM infrastructure including software, hardware, and workspaces.

Personnel: The roles and responsibilities of the active participants in the BIM Process, including the organizational structure or hierarchy, the education and training programs, and change readiness.

1.7 BIM Uses

A BIM Use is *a method or strategy of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives*. This Guide includes the common Uses of BIM which have been identified and classified through the case studies, industry interviews, software analysis, and literature review as critical for the Owner. As BIM technology matures, additional BIM Uses will be documented. For a complete and up to date list of BIM Uses, please see the research project website (http://bim.psu.edu). The 'Operate' column of Figure 1-6 shows the Uses of BIM throughout the lifecycle of a facility, which are address in this Planning Guide. This list is not comprehensive, but instead, focuses on the critical Uses.

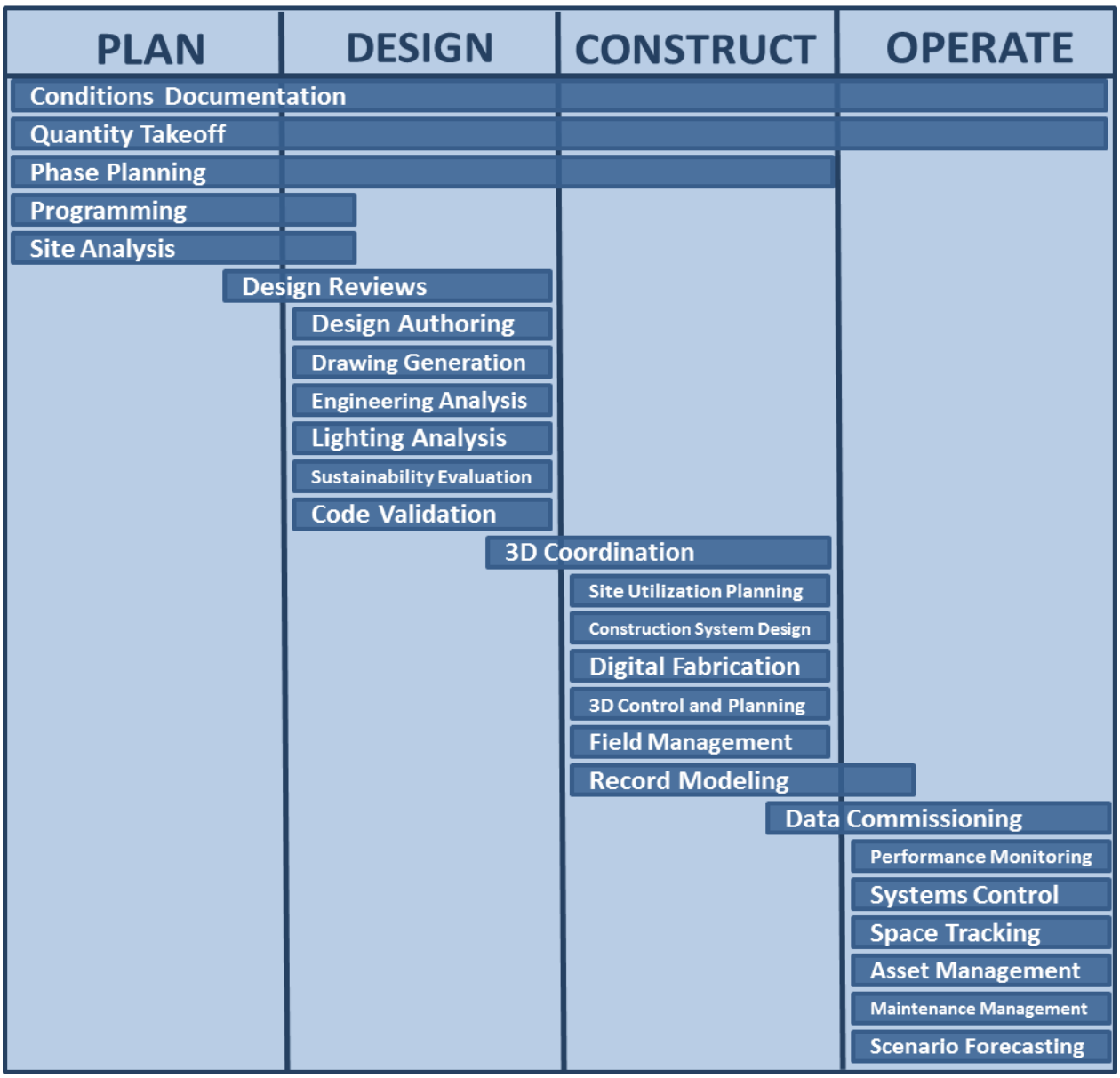


Figure 1-6: The Uses of BIM throughout the Lifecycle of a Facility

1.7.1 Organizational BIM Uses for Owners

There are many ways in which BIM can be used to improve a facility owner's processes. The following, while not a comprehensive list, are specific methods that BIM can be utilized for one or more specific purposes that are specifically applicable to facility owners. In most cases, owners are already performing these items, however without the context of BIM. The integration of BIM and facility data within these tasks allow for more improved and often more cost effective processes. Some of the more critical BIM Uses include:

- **Data Commissioning:** A process in which facility data, such as part numbers, warranty information, from a BIM Model is used to populate an organization's facility management system (FMS) while ensuring the accuracy of the information and significantly reducing the data entry time.
- **Performance Monitoring:** A process in which BIM can be used to assist in monitoring the performance of the facilities including items such as energy, air quality, and security.
- **Systems Control:** A process in which BIM can be used to assist in controlling elements or systems of the facility such as lighting, electrical, HVAC, and conveying.
- **Space Tracking:** A process in which BIM is used to monitor the usage of spaces within the facility.
- **Asset Management:** A process in which BIM is used to assist in the management of facility assets to ensure optimal value over its life cycle. These assets, consisting of the physical building, systems, surrounding environment, and equipment, must be maintained, upgraded, and operated at an efficiency, which will satisfy both the owner and users at the lowest appropriate cost to support financial decision-making as well as short-term and long-term planning. Asset categories can include personnel, space, equipment, systems, FF&E systems and components, IT and AV systems components and other data to be determined to be of value by each customer.
- **Maintenance Management:** A process in which BIM is used to assist in actions intended to retain facility elements, or restore facility elements to, a state in which the facility element can perform its intended function.
- **Condition Documentation:** A process in which BIM is used to assist in recording the state of the facility. This can be accomplished with a number of tools including but not limited to laser scanning, photo-geometry, and traditional surveying.
- **Scenario Forecasting:** A process in which BIM is used to predict possible situations within the facility such as crowd flow, evacuation procedures and other disasters.

2 BIM Organizational Strategic Planning

An organization should conduct strategic planning to make informed decisions to establish organizational goals and establish a direction for the organization. Overtime, a strategic plan will help an organization's business move in the intended direction and to accomplish those goals. The planning activities help an organization to understand the organization's mission, vision, and goals, and determine the means and methods of achieving them. As John M. Bryson defines it in his book, Strategic Planning for Public and Non-profit Organizations[6]:

> "*Strategic planning is a set of concepts, procedures, and tools designed to assist leaders and managers with these tasks. Indeed, strategic planning may be defined as a disciplined effort to produce fundamental decisions and actions that shape and guide what an organization (or other entity) is, what it does, and why it does it".*

Strategic planning focuses on an organization's internal capabilities and its performance in the external environment. This requires an assessment of the organization including mission and objectives, resources and competencies, the market forces, technological drivers, and other factors that influence the strategic approach of the organization. By following a structured procedure, the organization is able to maintain a direction and focus towards end goals.

Strategic planning for Building Information Modeling (BIM) is the application of the strategic planning processes and tools focused upon implementing and integrating BIM within an organization. The planning sets a foundation for the adoption and integration strategy of BIM within organizational functional processes. A systematic and planned approach to BIM will guide the organization to integrate BIM with minimal risk. Strategic planning uses a number of methods and tools to gather, analyze, and distribute information including, for example, organizational assessment, Strength Weakness Opportunity Threat (SWOT) analysis, and roadmapping to guide an organization. Some of the information can include the acquisition of resources for implementation; methods of implementation; process changes or improvements; BIM Uses; infrastructure requirements; personnel and management; procurement strategies; and other supporting information.

Any organization planning for internal process improvements should consider a number of alternative options to achieve organizational objectives and goals. Planning for BIM has to start with first accepting BIM as an alternative and a feasible opportunity to streamline/simplify facility operations. Without the acceptance of BIM at the forefront, the planning committee will not be entirely focused and dedicated to investigate all possible solutions and scenarios with its implementation. The strategic planning committee should focus efforts towards maximizing value by diligent planning methods. While organizations might be looking for sources that provide a "one solution fits all approach" to planning the implementation of BIM, it is important to understand that no two organizations are exactly alike. Keeping that constraint in mind, the BIM strategic planning procedure described in this section offers an approach to developing solutions tailored for individual organizations.

[6] J.M. Bryson, *Strategic Planning for Public and Nonprofit Organizations: A Guide to Strengthening and Sustaining Organizational Achievement*, vol. 1 (Jossey-Bass, 2011).

2.1 The Need for BIM Strategic Planning

Strategic Planning helps ensure an organization is ready for the implementation of a new process or technology with planned resources. However, research has shown that strategic planning can fail in organizations for a number of reasons. Some of these reasons include, for example, a lack of authority or leadership, a lack of communication, failure to manage change, improper planning for time and resources, and lack of motivation.[7,8] Strategic planning can promote collaboration within an organization for clear foresight. These activities ensure that the necessary factors for strategic planning and advancement are considered and greatly reduce the chances of failure. For any organization, strategic planning is beneficial for several reasons. Some of the benefits of strategic planning for BIM are:

- Clearly understanding the purpose and missions of the organization;
- Consistently defining organizational goals and BIM objectives for the organization which align with its mission in a given time frame;
- Effectively allocating organizational resources on key BIM competencies and priorities;
- Providing a benchmark from which progress in each of the competency categories can be measured at milestones to assess transitions; and
- Promoting teamwork and broader perspectives for planning with multiple opinions from different individuals within an organization for rationalized decision-making.

Like any new process, BIM implementation within an organization has a learning curve associated with it. This is of importance for organizations with relatively low or no experience with BIM as a lack of familiarity can carry risks for implementation. With more detailed planning, the organization will be able to achieve improved clarity of the process, which will reduce risk to the organization.

2.2 Owner's Strategic Planning Procedure

The Strategic Planning for BIM procedure will direct the planning team through three steps to develop a detailed BIM Owner Organizational Execution Plan. These steps were developed through multiple research methods, which includes interviews and focus group meetings with industry partners, an analysis of existing planning documents, and a study of the ongoing planning process at three major organizations.

Figure 2-1 illustrate the three essential steps in developing a BIM Organizational Strategic Plan: 1) Conduct Organizational Assessment, 2) Establish Desired Level of Implementation, and 3) Develop Advancement Strategy. Templates have been created to support each of these steps and to document the relevant information. These templates are included in the appendices and are also at http://bim.psu.edu

[7] Paul Johnson, "The Top Five Reasons Why Strategic Plans Fail," *Business Know How*, 2002, http://www.businessknowhow.com/manage/splanfail.htm.
[8] Amanda Gregory, "A Systems Approach to Strategic Management," *Proceedings of the 51st Annual Meeting of the ISSS* 51, no. 2 (July 31, 2007), http://journals.isss.org/index.php/proceedings51st/article/view/840.

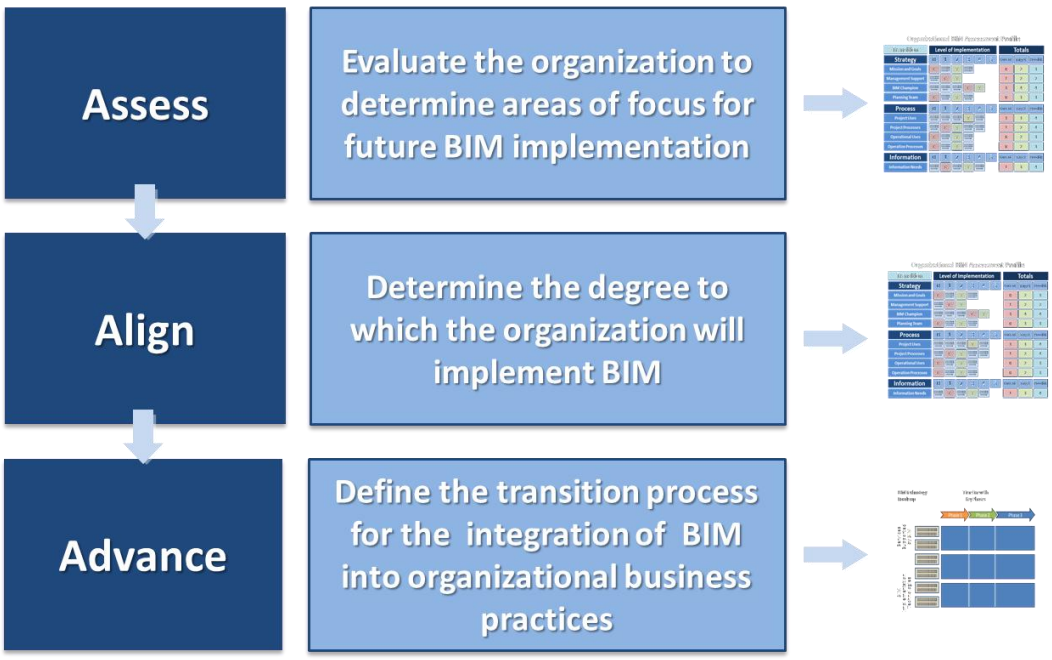


Figure 2-1: BIM Organizational Strategic Planning Procedure

2.2.1 The BIM Planning Committee

The strategic planning procedure should be initiated by an individual or group able to adequately direct funds and guides the procedure. It is important that an individual with authority, leadership, and motivation is selected to champion this process. A BIM Champion is *a person who is technically skilled and motivated to guide an organization to improve their processes by pushing adoption, managing resistance to change, and ensuring implementation of a new technology or process*. Apart from the Champion, the planning committee should include individuals who have a background knowledge of and experience with BIM. In cases where the organization is cannot compile a planning committee with BIM experience, an outside party experienced with BIM could facilitate the planning. As strategic planning for BIM also includes an assessment across the entire organization apart from the external analysis, involving representatives of the operating units that are part of the organization, while not always required, is beneficial.

The members of the BIM planning committee, when formed internally, include individuals from across the organizational structure: top management levels and stakeholders, middle managers, and the technical workforce. Without the involvement of high-level executives, it is most likely that the planning team will not be able to gain the necessary resources to plan and implement the recommendations that are developed. By including executives, key decisions to proceed are more easily facilitated.

Middle managers are responsible for operating their departments and carrying out goals set by the planning process. They are a direct representative of the technical workforce. They are responsible for the daily operations of their divisions by monitoring and delegating work and making sure processes are

managed. These managers should be involved to plan for the change and manage resistance, if any, to the transition.

The rest of the workforce includes personnel who are directly involved with the technology and processes that drive the goals of the organization on a daily basis. These personnel are the most experienced in terms of the operations and use technologies and processes within the organization. They are likely to be the most affected by any change to the process. Being responsible for the standard workflow subject to change due to integrating BIM, they are also the most likely to resist the change. Involving them in planning will help the committee to understand the challenges faced for technical and process improvements or changes.

When assembling the BIM planning committee, considerations should be given to involving personnel with specific responsibilities and capabilities including:

- An individual who can champion the planning within the organization,
- Decision makers who have authority to grant access to resources (time, funding, personnel, and infrastructure) required by the team,
- Individuals who might be directly affected by the adoption or change,
- Motivated individuals who can contribute to the process and are open to change,
- Implementers of the BIM process, and
- Individuals to monitor progress and manage change.

An optimal balance should be maintained when choosing the individuals for the committee. A committee with a small number of members might seem to lack the energy and motivation, whereas a team with too many members might lead to less strategic discussions.

2.2.2 Readiness Assessment

The planning committee needs to consider the readiness for change of the organization. Without ensuring that the committee has assessed the needs and accommodated for these pre-requisites, it will be difficult to start strategic planning. A list of elements that the committee or the organization should consider before initiating the strategic planning procedure includes:

- Defining the BIM Champion, a planning committee, or a consultant to initiate the procedure;
- Gaining involvement and buy-in from the top-level management and stakeholders;
- Establishing the availability of adequate time, resources, and funds for the planning effort; and
- Gaining a fundamental understanding that the strategic planning for BIM is a continual effort, and is not a one-time event.

2.3 Assess: Conduct Organizational BIM Assessment

As the first step of the BIM Organizational Strategic Planning Procedure, the owner can conduct a self-assessment of the organization. The assessment includes evaluating the organization, both internally to determine their status and externally to determine its performance within its business environment. The goal of this process is to identify possible areas of adoption and implementation of new processes and technologies. An assessment is usually required to review the various aspects of the organization that

need change or be modified to facilitate the transformation. This step allows the planning team to determine which aspects of the organization are working well, and identify those that are in need of improvement. It is a broader view of where the organization stands in the external environment that allows the planning committee to leverage its assets and determine the need to perform actions to improve an existing processes or technologies.

2.3.1 Understanding the Organization: Mission, Vision, Goals and Objectives

As part of the assessment to determine status, capabilities, challenges and other attributes of an organization, the planning committee should start with an assessment of the organizational mission, vision, goals, and objectives. While most organizations have their mission and vision defined, some organizations occasionally find themselves in the process of revisiting their purpose of existence. This helps the planning committee to efficiently plan and to keep the activities focused.

2.3.1.1 Organizational Mission

A mission statement describes *the purpose for the existence of an organization.* The statement helps to distinguish organizations from one another. Referring to the business principles and beliefs, the mission statement helps manifest a culture among the members of the organization. In some instances, mission statements do not stop with the organizational levels, but extend into the different units that make up the organization. The mission statements of these individual supporting units help in defining the overall mission of the organization.

The reasons for a mission statement include purpose, unanimity, culture depiction, focus on services, customer relations, and articulation of goals and objectives.[9] For organizations that do not have an established mission statement, it is important to develop one aid in the effective planning and implementation of BIM. A basic mission statement could include information on one or more of the following components: customers, products and services, technology, philosophy, concern for competition and market, employee satisfaction, and revenue or financial visions.[10,11] The mission statement should be as concise as possible and perhaps be a one-sentence definition of the aforementioned attribute. The organization should also consider stating a mission for the individual facilities groups within the organization. When determining the mission of the facilities group, it must be remembered that these units support the organization in achieving its overarching mission. Therefore, missions of the facilities group must be stated as performing their internal objectives with an aim toward enhancing organizational mission. This mission statement should then be documented in the BIM Organizational Strategic Plan.

[9] J. W. Graham and W. C. Havlick, *Mission Statements: A Guide to the Corporate and Nonprofit Sectors*, vol. 900 (Routledge, 1994).
[10] William M Drohan, "Writing a Mission Statement," *Association Management* 51, no. 1 (January 1999): 117.
[11] Bryson, *Strategic Planning for Public and Nonprofit Organizations*.

CASE STUDY EXAMPLE: Organizational Mission Statements

The Pennsylvania State University states its mission as "a multi-campus public research university that educates students from Pennsylvania, the nation and the world, and improves the well-being and health of individuals and communities through integrated programs of teaching, research, and service". The Office of the Physical Plant at Penn State that supports the facilities on campus defines its supporting mission statement as "To promote wise stewardship of the University's physical plant and provide responsive, quality, and cost-effective services in support of the University's mission of teaching, research, and service".

Kaiser Permanente states its purpose as an organization that "exists to provide affordable, high quality healthcare services to improve the health of our members and the communities we serve".

2.3.1.2 Organizational Vision and Goals

An organizational vision statement shares the intended future state of an organization. This is unlike the mission statement, which focuses more on the purpose of the organization's existence and culture. A vision statement traditionally follows a mission statement. Organization's defined goals and objectives based on vision and mission statements. Organizational goals and vision statements are interrelated in that vision can be defined as a future state or end goal that is made up of a number of shorter term goals. Working through the organizational hierarchy, the nature of vision and goals vary with granularity and specificity. Goals can be categorized into three different levels: strategic, tactical, and operational goals. When developing goals for the organization, working from a top down approach will help identify the goals of the operating units and support organizations. When establishing goals, they should be specific, measurable, attainable, realistic, and timely.[12] These goals should be defined for a specific period that will help the BIM planning committee during the roadmapping and execution processes.

CASE STUDY EXAMPLE: Organizational Vision Statements

Examples of organizational vision statements include **The Pennsylvania State University** and **Kaiser Permanente**. The Pennsylvania State University's vision is to "be a global university, committed to excellence, with a passion for creating knowledge and educating students to be leaders for a better tomorrow.[13]" **Kaiser Permanente** visualizes itself "To be the model for quality health care in the nation by being the best place to work and the best place to receive care.[14]"

2.3.2 Organizational Performance Analysis

Once the organization's mission and goals are reviewed, the BIM planning committee needs to assess how it will satisfy the vision. By analyzing business performances, teams will be able to identify key performance indicators. Analyzing the performance indicators will help determine which aspects of the organization need to be changed or managed as the organization moves in the planned direction. Apart from identifying status, performance measures are assessed to control behavior towards the intended goal;

[12] G. T. Doran, "There's a S.M.A.R.T. Way to Write Management's Goals and Objectives," *Management Review* 70, no. 11 (1981): 35–36.
[13] Penn State University, "Strategic Planning at Penn State," 2009, http://strategicplan.psu.edu.
[14] "Kaiser Permanente Our Mission," n.d., http://mydoctor.kaiserpermanente.org/ncal/facilities/region/eastbay/area_master/about_us/missionstatement.jsp.

inform external stakeholders of information requirements; and empower decision making.[15] Organizations can benchmark their performance against other organizations to determine opportunities for improving their processes.[16]

Most strategic planning literature specifies that internal and external analysis include an assessment of the administrative, political, economic, stakeholder, and technological features. For a facility owner, however, these aspects also include the business processes, organizational structure, organizational culture, procurement strategies, financial considerations, and market positions. To assess these features within an organization, several approaches have been used in the past. Some of these techniques include:

- Process Performance Measurement Systems (PPMS),
- Balanced Scorecards,[17]
- Workflow Based Monitoring,
- Statistical Process Control,
- Activity-based costing systems,
- Capability Maturity Model, and
- Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis.

The choice of the most appropriate method of analysis should be made by the BIM planning committee based on the level of detail and quality of results desired as part of this phase. Regardless of the choice of methods, the planning committee must aim to evaluate the processes both qualitatively to support decisions and quantitatively to make absolute measurements.

2.3.3 Document Current Implementation of BIM

During BIM organizational strategic planning, the planning committee should measure the maturity of the aspects of an organization, or BIM planning elements, that are critical for its BIM implementation. The BIM planning elements include organizational aspects or categories that were identified as important aspects to be considered for the adoption and integration of BIM. While organizations would benefit from an analysis of these elements for BIM implementation, organizations must not limit their assessment to these suggested elements and should include other aspects they deem necessary. A BIM Organizational Assessment Profile has been developed to assist the planning committee with assessing these elements.

There are a number of ways the organization can collect information to assess their status. The most common and efficient method of gathering the required information is by conducting interviews with the operating unit's personnel who are directly involved with the performance of the organization. Other methods that supplement this process include organizational wide surveys, document analysis, process observations, and workflow analysis. Example questions that could be used to assess the current

[15] B. Marr, *Managing and Delivering Performance: How Government, Public Sector and Not-for-profit Organisations Can Measure and Manage What Really Matters* (Elsevier Science & Technology, 2008).
[16] P. Kueng, "Process Performance Measurement System: a Tool to Support Process-based Organizations," *Total Quality Management* 11, no. 1 (2000): 67–85.
[17] R.S. Kaplan and D.P. Norton, *The Balanced Scorecard: Translating Strategy into Action* (Harvard Business Press, 1996).

condition of an organization and its units could be related to duties of the organizational unit, information they manage, process of managing information, some of the challenges associated with the process, etc.

2.3.3.1 Planning Elements

Throughout all stages of the BIM Organizational Strategic Planning, these are core elements that will be assessed to determine the implementation strategies. These planning elements include:

- **Strategy:** The mission, vision, goals and objectives of the organization, along with the management to support the process, a BIM Champion and a BIM planning committee.
- **BIM Uses:** The specific purposes for implementing BIM. These are further categorized into those Uses that generate, process, communicate, execute, and manage facility information.
- **Processes:** The means and methods by which BIM Uses are accomplished. These are categorized under external BIM project processes and internal BIM organizational processes.
- **Information:** This includes an assessment of the Model Element Breakdown, Level of Development, and Facility Data specifications.
- **Infrastructure:** Technological and physical systems needed for the operation of BIM within the organization including software, hardware, and physical spaces.
- **Personnel:** The human resource items related to BIM within an organization. This includes the roles and responsibilities, the organizational hierarchy, education programs, training capabilities and change readiness for BIM.

2.3.3.2 Overview of Assessment Tool

The Organizational BIM Assessment Profile is a matrix, which has been developed for the purpose of assessing the organization's maturity of the planning elements. The first step of using the maturity profile for the planning committee is to determine the current maturity level of each of the planning elements. This can be completed by scoring their maturity based on the description given in the matrix. The profile provides a basic description for each the maturity levels identified within the planning elements. The Level of Maturity begins with zero (0), which represents non-existence or non-use of that element within the organization and continues to level five (5) in which the planning element is optimized. By using the assessment profile, the organization can quickly document the implementation status for each category. Figure 2-2 shows a section of the Organizational BIM Assessment Profile, with an example of the current maturity level highlighted.

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
Strategy	the Mission, Vision, Goals, and Objectives, along with management support, BIM Champions, and BIM Planning Committee.	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**11**	**0**	**25**
Organizational Mission and Goals	A **mission** is the fundamental purpose for existence of an organization. **Goals** are specific aims which the organization wishes to accomplish.	No Organizational Mission or Goals	Basic Organizational Mission Established	Established Basic Organizational Goals	Organization Mission which addressed purpose, services, values (at a minimum)	Goals are specific, measurable, attainable, relevant, and timely	Mission and Goals are regularly revisited, maintained and updated (as necessary)	1	0	5
BIM Vision and Objectives	A **vision** is a picture of what an organization is striving to become **Objectives** are specific tasks or steps that when accomplished move the organization toward their goals	No BIM Vision or Objectives Defined	Basic BIM Vision is Establish	Established Basic BIM Objectives	BIM Vision address mission, strategy, and culture	BIM Objectives are specific, measurable, attainable, relevant, and timely	Vision and Objectives are regularly revisited, maintained and updated (as necessary)	2	0	5
Management Support	To what level does management support the BIM Planning Process	No Management Support	Limited Support for feasibility study	Full Support for BIM Implementation with Some Resource Commitment	Full support for BIM Implementation with Appropriate Resource Commitment	Limited support for continuing efforts with a limited budget	Full Support of continuing efforts	3	0	5
BIM Champion	A BIM Champion is a person who is technically skilled and motivated to guide an organization to improve their processes by pushing adoption, managing resistance to change and ensuring implementation of BIM	No BIM Champion	BIM Champion identified but limited time committed to BIM initiative	BIM Champion with Adequate Time Commitment	Multiple BIM Champions with Each Working Group	Executive Level BIM Support Champion with limit time commitment	Executive-level BIM Champion working closely with Working Group Champion	3	0	5
BIM Planning Committee	The BIM Planning Committee is responsible for developing the BIM strategy of the organization	No BIM Planning Committee established	Small Ad-hoc Committee with only those interested in BIM	BIM Committee is formalized but not inclusive of all operating units	Multi-disciplinary BIM Planning Committee established with members from all operative units	Planning Committee includes members for all level of the organization including executives	BIM Planning Decisions are integrated with organizational Strategic Planning	2	0	5
BIM Uses	The specific methods of implementing BIM	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**2**	**0**	**10**
Project Uses	The specific methods of implementing BIM on projects	No BIM Uses for Projects identified	No BIM Uses for Projects identified	Minimal Owner Requirements for BIM	Extensive use of BIM with limited sharing between parties	Extensive use of BIM with sharing between parties within project phase	Open sharing of BIM Data across all parties and project phases	1	0	5
Operational Uses	The specific methods of implementing BIM within the organization	No BIM Uses for Operations identified	Record (As-Built) BIM model received by operations	Record BIM data imported or referenced for operational uses	BIM data manually maintained for operational uses	BIM data is directly integrated with operational systems	BIM data maintained with operational systems in Real-time	1	0	5
Process	The means by which the BIM Uses are accomplished	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**2**	**0**	**10**
Project Processes	The documentation of External Project BIM Processes	No external project BIM Processes Documented	High-level BIM Process Documented for Each Party	Integrated High Level BIM Process Documented	Detailed BIM Process Documented for Primary BIM Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	1	0	5
Organizational Processes	The documentation of Internal Organizational BIM Processes	No internal organizational BIM Processes Documented	High-Level BIM Process Documented for each operating unit	Integrated High level organizational Process documented	Detailed BIM Process Document for primary organizational Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	1	0	5

Figure 2-2: Organizational BIM Assessment Profile (See Appendix A)

2.4 Align: Establish Desired level of Implementation

The second step to achieve BIM goals is a strategic alignment of the organization. Once the organization has conducted an internal assessment of its status, the BIM planning committee then establishes a desired level of maturity for each of the planning elements. Careful deliberation has to be exercised with a choice of a level that would be measurable and achievable. The inherent capabilities of an organization, its experience and knowledge, and readiness for change are some of the competencies that have to be considered when targeting maturities. Additionally the planning committee will need to determine future BIM Objectives and BIM Uses for the organization.

2.4.1 Establish Desired Levels of Implementation Maturity

Having mapped the status of the planning elements within the organization, the desired levels should be identified in the maturity profile. These desired levels should be the areas which would need to be achieved for reaching the BIM Objectives. An organization may not need to advance to level five to obtained the desire level of BIM implementation.

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
Strategy	the Mission, Vision, Goals, and Objectives, along with management support, BIM Champions, and BIM Planning Committee.	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**11**	**17**	**25**
Organizational Mission and Goals	A **mission** is the fundamental purpose for existence of an organization. **Goals** are specific aims which the organization wishes to accomplish.	No Organizational Mission or Goals	Basic Organizational Mission Established	Established Basic Organizational Goals	Organization Mission which addressed purpose, services, values (at a minimum)	Goals are specific, measurable, attainable, relevant, and timely	Mission and Goals are regularly revisited, maintained and updated (as necessary)	1	3	5
BIM Vision and Objectives	A **vision** is a picture of what an organization is striving to become **Objectives** are specific tasks or steps that when accomplished move the organization toward their goals	No BIM Vision or Objectives Defined	Basic BIM Vision is Establish	Established Basic BIM Objectives	BIM Vision address mission, strategy, and culture	BIM Objectives are specific, measurable, attainable, relevant, and timely	Vision and Objectives are regularly revisited, maintained and updated (as necessary)	2	3	5
Management Support	To what level does management support the BIM Planning Process	No Management Support	Limited Support for feasibility study	Full Support for BIM Implementation with Some Resource Commitment	Full support for BIM Implementation with Appropriate Resource Commitment	Limited support for continuing efforts with a limited budget	Full Support of continuing efforts	3	4	5
BIM Champion	A BIM Champion is a person who is technically skilled and motivated to guide an organization to improve their processes by pushing adoption, managing resistance to change and ensuring implementation of BIM	No BIM Champion	BIM Champion identified but limited time committed to BIM initiative	BIM Champion with Adequate Time Commitment	Multiple BIM Champions with Each Working Group	Executive Level BIM Support Champion with limit time commitment	Executive-level BIM Champion working closely with Working Group Champion	3	4	5
BIM Planning Committee	The BIM Planning Committee is responsible for developing the BIM strategy of the organization	No BIM Planning Committee established	Small Ad-hoc Committee with only those interested in BIM	BIM Committee is formalized but not inclusive of all operating units	Multi-disciplinary BIM Planning Committee established with members from all operative units	Planning Committee includes members for all level of the organization including executives	BIM Planning Decisions are integrated with organizational Strategic Planning	2	3	5
BIM Uses	The specific methods of implementing BIM	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**2**	**5**	**10**
Project Uses	The specific methods of implementing BIM on projects	No BIM Uses for Projects identified	No BIM Uses for Projects identified	Minimal Owner Requirements for BIM	Extensive use of BIM with limited sharing between parties	Extensive use of BIM with sharing between parties within project phase	Open sharing of BIM Data across all parties and project phases	1	3	5
Operational Uses	The specific methods of implementing BIM within the organization	No BIM Uses for Operations identified	Record (As-Built) BIM model received by operations	Record BIM data imported or referenced for operational uses	BIM data manually maintained for operational uses	BIM data is directly integrated with operational systems	BIM data maintained with operational systems in Real-time	1	2	5
Process	The means by which the BIM Uses are accomplished	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**2**	**5**	**10**
Project Processes	The documentation of External Project BIM Processes	No external project BIM Processes Documented	High-level BIM Process Documented for Each Party	Integrated High Level BIM Process Documented	Detailed BIM Process Documented for Primary BIM Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	1	3	5
Organizational Processes	The documentation of Internal Organizational BIM Processes	No internal organizational BIM Processes Documented	High-Level BIM Process Documented for each operating unit	Integrated High level organizational Process documented	Detailed BIM Process Document for primary organizational Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	1	2	5

Figure 2-3: Organizational BIM Assessment Profile with Desired State

The alignment to desired Level of Maturity may take a considerable amount of time. The planning committee will need to not only identify the desired levels, but also investigate further to extract information that will assist in making better choices on the path forward. It is important to consider the difference between the desire and ability of the organization. An organization has to understand that while it might desire reaching a particular level of maturity; it also needs to plan the outcome based on its ability to do so over a realistic period.

2.4.2 BIM Planning Committee Mission

When planning for integration of BIM within an organization, the BIM Planning Committee should develop a mission statement for itself. Like an organizational mission statement, the BIM Planning Committee Mission states the purpose for the existence of the BIM Planning Committee. A mission statement for the BIM Planning Committee stems from an understanding of a number of items including: the type of the organization; the mission and vision of the organization; the facilities group(s) that support the organization; and the challenges faced by these operating units.

The scope and focus of a committee's Mission Statement can vary based on the expertise and level of understanding of the committee. The committee's statement generally explains their existence to achieve the organizational mission and vision with the use of BIM, or extend into details by mentioning an improvement in a specific process or technology for the organization.

CASE STUDY EXAMPLE: BIM Planning Committee Mission Statements

Kaiser Permanente's National Facilities Services (NFS) BIM Work Team's mission statement establishes its function as gathering information and helping the NFS BIM Strategy for planning the adoption and implementation of BIM for Kaiser Permanente. The mission reads "*to gather information from across the NFS enterprise, report*

findings, deliver recommendations for the NFS BIM Strategy, and identify work tracks/action plans to execute on the strategy". It goes further to elaborate its purpose as to "*Define the role of BIM in the Healthcare Facility Life Cycle Management (FLCM) and to establish the Healthcare BIM Consortium (HBC) and industry partners.*[18]"

The Healthcare BIM Consortium (HBC), a collaboration of healthcare owners, software vendors, designers and builders has a more specified BIM Mission. The consortium exists to "*seek solutions for interoperability to support the Facility Life Cycle Management (FLCM).*[19]"

2.4.3 Organizational Goals with BIM

Setting goals is an important step following the establishment of a mission by the strategic BIM planning committee. As a first pass in the strategic planning process, the goals identified can vary in scope and degree. These goals can be based on organizational performance and include items such as invest in BIM, reduce operational and lifecycle costs, improve operational workflows, understand and define information needs or develop internal quality assurance systems. Goals can also target the workforce and their capabilities by providing training and education to the team members or developing supporting infrastructure. These are only an example list of goals. It is incumbent upon the committee to identify goals that provide value to the organization.

The planning committee should understand the function of the operating units and their role in the organization. When determining goals, the planning committee should analyze their capabilities and their level of expertise. A planning committee should not limit goals to the operational phase, but instead look to develop multiple goals and add value across the entire lifecycle of a facility. The goals will be further refined, revised, categorized, and prioritized in detail as part of the BIM Organizational Execution Planning Procedure.

Table 2-1: Example Organizational Goals

PRIORITY (Required, Recommended)	STRATEGIC GOAL
Required	Improve work order management through the timely entry of facility data into the facility management system (FMS)
Required	Provide facility managers improved facility data after building turnover
Recommended	Reduce energy use by integrating more detailed energy analysis

2.4.4 BIM Objectives

Once the BIM planning committee has identified organizational goals, BIM objectives are defined. Objectives are more specific and measurable steps for achieving a goal or a long-term vision. When developing objectives, the planning committee has to consider each identified goal in detail and analyze it further to identify the steps required to attain each objective. Once the objectives have been determine, they should be ordered based on time and priority. Examples of objectives include identify process flows,

[18] "bSa Active Projects | The National Institute of Building Sciences," n.d., http://www.buildingsmartalliance.org/index.php/projects/activeprojects/162.
[19] "bSa Active Projects | The National Institute of Building Sciences."

understand Facility Management System (FMS) requirements, integrate planning and design tools with operational tools and applications, or define roles and responsibilities of the organizational members.

2.4.5 Determine BIM Uses

After determining the organizational goals and BIM objectives, the organization should determine the BIM Uses to achieve their goals. A BIM Use is defined as *a method or strategy of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives*. The BIM Uses at this stage of the planning process are identified based on the goals and objectives. For example, if an organization wants to manage as-built records and maintenance information on the building equipment, record modeling, and asset management could be potential BIM Uses. Some goals and objectives may directly imply the specific implementation of a BIM Use, while others may require several Uses may support a goal. A more detailed list of BIM Uses with descriptions has been provided as an appendix and at the website http://bim.psu.edu.

GOAL	BIM USES
Improve construction quality	Design Review, Design 3D Coordination, Digital Fabrication
Reduce RFIs and Change Orders	Design Review, 3D Coordination
Reduce Energy Use	Energy Analysis, Performance Monitoring
Provide Facility Managers Improved Facility Data after Building Turnover	Record Modeling, Existing Conditions Modeling

2.5 Advance: Develop an Advancement Strategy

BIM Strategic Planning does not stop with developing short-term goals and long-term visions, but with a final step of developing an effective advancement and implementation strategy. The implementation process will vary from one organization to another depending on the goals and objectives; the size of the organization; time and financial investment; experience with BIM and the available resources. Advanced planning helps the planning committee determine a defined approach to avoid the risk of escalating costs and misdirected time and resources. Strategic planning established a baseline to track progress at predetermined milestones or points in time. A typical action plan for organizational advancement should document in the following:

- Mission and vision of the organization,
- Organizational goals and BIM objectives,
- BIM organizational planning elements to be addressed,
- Expected results for planning elements with the time frames and schedules
- Roles and responsibilities for the implementation period,
- Communication structure and channel,
- Documentation procedure,
- Technological and financial resources required for the duration of the planning procedure,
- Midcourse risk management procedure, and
- Feedback loop.

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
Strategy	the Mission, Vision, Goals, and Objectives, along with management support, BIM Champions, and BIM Planning Committee.	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**11**	**17**	**25**
Organizational Mission and Goals	A **mission** is the fundamental purpose for existence of an organization. **Goals** are specific aims which the organization wishes to accomplish.	No Organizational Mission or Goals	Basic Organizational Mission Established	Established Basic Organizational Goals	Organization Mission which addressed purposes, practices, values (at a minimum)	Goals are specific, measurable, attainable, relevant, and timely	Mission and Goals are regularly revisited, maintained and updated (as necessary)	1	3	5
BIM Vision and Objectives	A **vision** is a picture of what an organization is striving to become **Objectives** are specific tasks or steps that when accomplished move the organization toward their goals	No BIM Vision or Objectives Defined	Basic BIM Vision is Establish	Established Basic BIM Objectives	BIM Vision address [illegible] and culture	BIM Objectives are specific, measurable, attainable, relevant, and timely	Vision and Objectives are regularly revisited, maintained and updated (as necessary)	2	3	5
Management Support	To what level does management support the BIM Planning Process	No Management Support	Limited Support for feasibility study	Full Support for BIM Implementation with Some Resource Commitment	Full support for BIM Implementation with Appropriate Resource Commitment	Limited support for [illegible] limited budget	Full Support of continuing efforts	3	4	5
BIM Champion	A BIM Champion is a person who is technically skilled and motivated to guide an organization to improve their processes by pushing adoption, managing resistance to change and ensuring implementation of BIM	No BIM Champion	BIM Champion identified but limited time committed to BIM initiative	BIM Champion with Adequate Time Commitment	Multiple BIM Champions with BIM Working Group	Executive-level BIM Support Champion with limit time Commitment	Executive-level BIM Champion working closely with Working Group Champion	3	4	5
BIM Planning Committee	The BIM Planning Committee is responsible for developing the BIM strategy of the organization	No BIM Planning Committee established	Small Ad-hoc Committee with only those interested in BIM	BIM Committee is formalized but not inclusive of all operating units	Multi-disciplinary BIM Planning Committee [illegible] members from all operative units	Planning Committee includes members for all level of the organization including executives	BIM Planning Decisions are integrated with organizational Strategic Planning	2	3	5
BIM Uses	The specific methods of implementing BIM	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**2**	**5**	**10**
Project Uses	The specific methods of implementing BIM on projects	No BIM Uses for Projects identified	No BIM Uses for Projects identified	Minimal Owner Requirements for BIM	Extensive use of BIM with sharing between parties	Extensive use of BIM with sharing between parties within project phase	Open sharing of BIM Data across all parties and project phases	1	3	5
Operational Uses	The specific methods of implementing BIM within the organization	No BIM Uses for Operations identified	Record (As-Built) BIM model received by operations	Record BIM data imported or referenced for operational uses	BIM data manually maintained for operational uses	BIM data is directly integrated with operational systems	BIM data maintained with operational systems in Real-time	1	2	5
Process	The means by which the BIM Uses are accomplished	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**2**	**5**	**10**
Project Processes	The documentation of External Project BIM Processes	No external project BIM Processes Documented	High-level BIM Process Documented for Each Party	Integrated High Level BIM Process Documented	Detailed BIM Process Documented for Primary BIM Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	1	3	5
Organizational Processes	The documentation of Internal Organizational BIM Processes	No internal organizational BIM Processes Documented	High-Level BIM Process Documented for each operating unit	Integrated high level organizational process documented	Detailed BIM Process Document for primary organizational Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	1	2	5

Figure 2-4: Step 3- Develop Advancement Strategy

The second section of the guide, BIM Organizational Execution Planning, discusses, in detail, the issues to consider when planning the advancement strategy for the BIM Planning Elements. This includes details on identifying enablers for graduating the planning elements across the different levels of maturity.

2.5.1 Strategic BIM Roadmap

Once the planning committee has documented their advancement strategy, the organization will benefit from developing a roadmap. Roadmapping is *the process of displaying the integration of strategic changes in a business process*. A roadmap quickly communicates the key components of the organizations strategic plan[20] in a simple graphical representation or snapshot view.

For organizations roadmapping their BIM strategy, it is valuable to understand the type of information to be displayed and the steps involved in developing a roadmap. The categories defined for developing a BIM organization strategic roadmap include:

- Planning elements;
- Time frame;
- Current status of the organization with BIM (Where are they now?);
- End state of the organization with BIM (Where they want to be?);
- Intermediate stages or milestones required to be achieved (How to get there?); and
- BIM uses that will be used internally within the organization.

Roadmaps are used as a tool to plan, visualize, and implement a strategy. There are a number of types that differ in use based on typology. While roadmapping literature suggests a numerous ways to develop a roadmap, the following sections define one approach.

[20] R. Phaal, C.J.P. Farrukh, and D.R. Probert, "Developing a Technology Roadmapping System," *Technology Management: A Unifying Discipline for Melting the Boundaries* 31 (2005).

2.5.1.1 *Types of Roadmaps*

The roadmapping procedure by the organization begins with the identification of the type and format of the roadmap that best suits the organization's requirements. The type can be classified based on purpose, format, and use. The BIM Planning Committee can choose from a range of roadmaps, which include:

Table 2-2: Types of Roadmaps[21]

Types	Categories
Purpose	Product planning, service/capability planning, strategic planning, long range planning, knowledge asset planning, program planning, process planning, and integration planning
Format	Multiple layers, bars, tables, graphs, pictorial representations, flow charts, single layer, and text
Use	One time or continuous

For the purpose of BIM integration within an organization, a good choice on the purpose of a roadmap should be a mix of strategic planning and integration planning. Strategic planning helps assess the strengths of the organization, the threats and challenges at the business and the operational levels. An integration planning roadmap helps focus on the evaluation and integration of a technology within an existing business process to strategically improve the existing process. The choice of the format depends on the audience. An organization could have the same roadmap displayed in a number of formats for the management level, and different format for the middle management, and yet another for the operational workforce.

2.5.1.2 *Developing the Roadmap*

The best roadmaps are developed by customizing them to align with the organizational requirements. As each organization is different in terms of its objectives and services it provides, therefore customization will be required to leverage maximum benefit from roadmapping. Some sections of a roadmap that should be considered by an organization are[22]:

1. **Time:** Time can be represented in a number of methods (i.e. months, quarters of a financial year, years, or milestones). Organizations should look to represent time in short intervals over months or years. The latter part of the time axis should be allocated to far reaching periods that provide space to display long-term vision and objectives of the organization.
2. **Integration / Strategic Drivers**: Most of the roadmapping effort should be spent on the developing integration/strategic drivers. To push the integration of a process or technology, it is important to identify the layers and sub layers, which are defined by the strategic drivers. The drivers also include the BIM Uses that the organization intends to integrate over the period determined by the BIM planning committee. The space on the earlier section along the time scale

[21] S. Lee and Y. Park, "Customization of Technology Roadmaps According to Roadmapping Purposes: Overall Process and Detailed Modules," *Technological Forecasting and Social Change* 72, no. 5 (2005): 567–583.
[22] R. Phaal, C. Farrukh, and D. Probert, "Technology Roadmapping: Linking Technology Resources to Business Objectives," *Centre for Technology Management, University of Cambridge* (2001): 1–18.

will display the current situation of these planning elements, the middle layer with the milestones or intermediate goals, and the later portion with the end state followed by the long-term vision.

3. **Supporting Information**: The planning committee needs to identify the information to be displayed on the roadmap in addition to time and the drivers. These items include the people responsible to implement the phases, checkpoints throughout the time frame, and links between drivers that support the advancement of one another.

The development of a detailed roadmap involves multiple work sessions or workshops with various members of the planning committee and the operational units of the organization. An analysis of the status, the desired level of maturity, and the gaps to be bridged should be identified. The sequence in which the BIM Planning Elements are to be approached should be assessed based on the organizational mission and goals.

CASE STUDY EXAMPLE: Penn State office of Physical Plan Roadmap

Figure 2-5 shows an example of Penn State's Office of Physical Plant's BIM Strategic Roadmap. The vertical axis delineates the levels of implementation within the organization, while the horizontal axis provides the goals with anticipate completion timeframes.

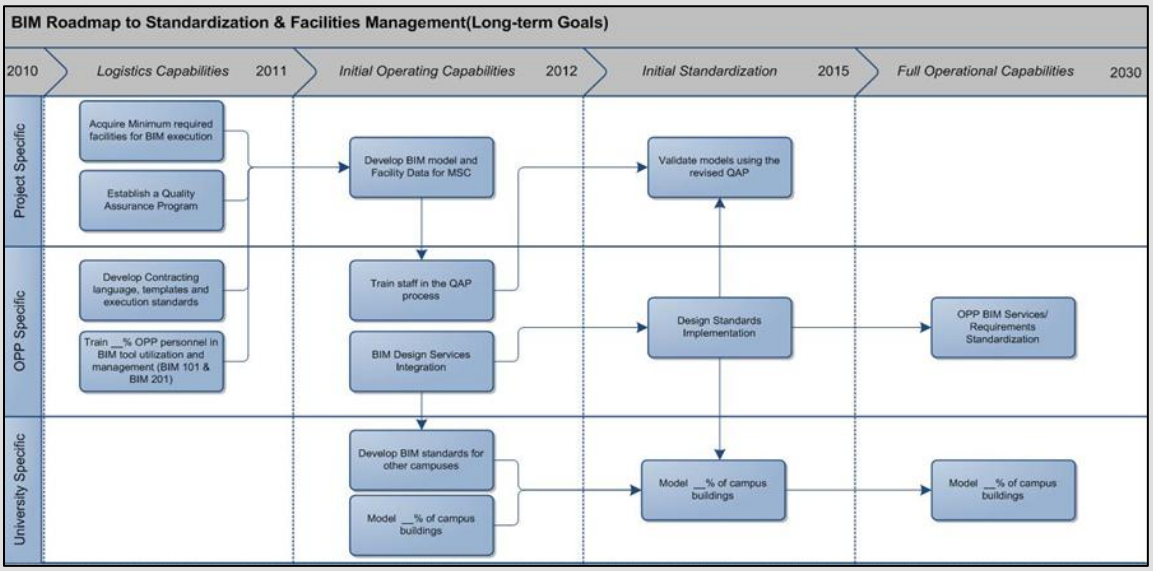


Figure 2-5: Penn State OPP Strategic BIM Roadmap

2.6 Documenting the Strategic Plan

As part of the BIM organizational strategic planning procedure, the decisions are documented in an accessible format. Documentation of this information benefits to the organization providing critical information for subsequent processes of BIM implementation. The information documented as part of this phase establishes the foundation for benchmarking and providing performance metrics at various points along the implementation timeline. The information gathered during the BIM organizational strategic planning procedure acts as the backbone for making important decisions and keeping BIM adoption controlled and directed.

2.7 Summary and Recommendations for BIM Strategic Planning

By following a comprehensive strategic planning procedure, including an assessment of the mission, vision, goals, planning elements, and developing a roadmap, an owner can document the information necessary to support decisions to integrate BIM within an organization.

The process which begins with an assessment of the organization helps benchmark its status in the market and identify gaps. Understanding organizational missions and goals helps determine the primary BIM objective of the organization and assess how it is currently achieving the organizational goals. Aligning the process by determining its vision for the future helps determine the BIM objectives and Uses that enable better facility throughout the lifecycle. The advancement strategy helps the organization develop future strategies by identifying important milestones and the key players. It helps the organization determine what elements need to be approached and in what manner to ensure the BIM process is focused.

With appropriate documentation, the owner will be able to successfully begin the next stage of BIM Organizational Execution Planning, where the planning elements and aspects of the organization identified during the BIM organizational strategic planning will be assessed in greater detail.

3 Owner BIM Organizational Execution Planning

After the organization has established a roadmap for the integration of BIM within its processes, the organization should then develop a detail plan to achieve the goals. During this stage, the goals of the strategic plan are translated into day-to-day projects and tasks to integrate BIM into the organization's processes. One of the reasons roadmapping efforts may not be successful is due to a failure to conduct detailed planning of the steps necessary to accomplish the strategic objectives. According to Robert Lear, only about 5% of strategic plans produce results because most other plans focus more on financial prediction than a schedule of tasks.[23] Strategic plans are also ineffective due to a lack of consistent and continuous communication of the plan. A BIM Organization Execution Plan, to complement the strategic plan, will help to overcome these obstacles.

The steps of the Organizational BIM Execution Planning Procedure, shown in Figure 3-1, include:

1. Establish BIM Vision and Objectives
2. Determine BIM Uses
3. Map Processes
4. Define Information Needs
5. Identify Infrastructure Needs
6. Plan Personnel Transition

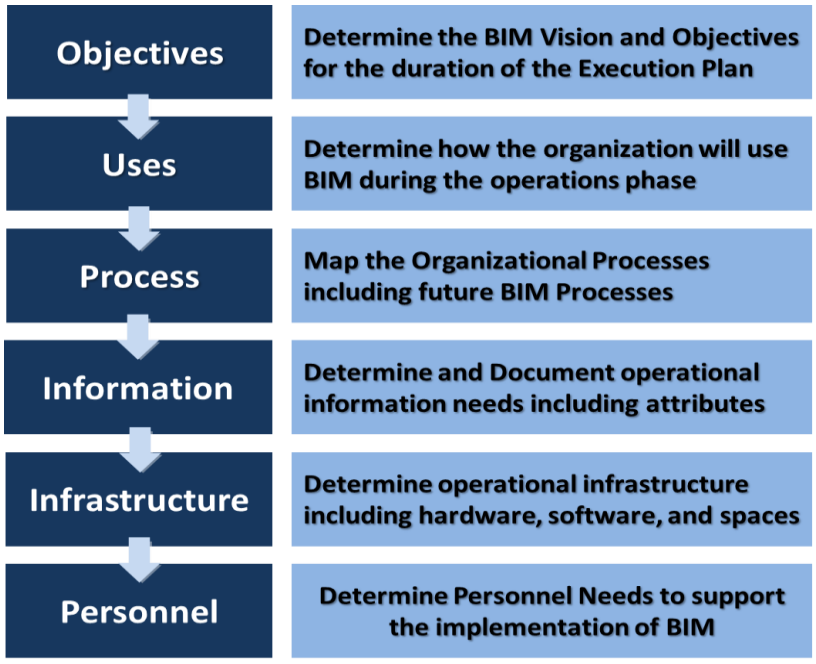


Figure 3-1: the Organizational BIM Execution Planning Procedure

When creating a BIM Organizational Execution Plan, the organization should only focus on the Uses of Building Information Modeling that will be performed by the organization itself. They will document

[23] Robert Lear, "Why Most Strategic Plans Fail," *Chief Executive* no. 110 (February 1996): 10.

necessary external information exchanges; however, they should only focus on those self-performed tasks that are affected by BIM implementation.

The creation of the BIM Organizational Execution Plan (herein after referred to as the "Plan") will require significant effort and resources. When creating the Plan, a BIM planning team should schedule time to complete each of the tasks understanding that each step of the procedure will take time. The plan can be created using several methods including:

- Creating a planning team with a representative of each operating unit participating. In this method, a meeting can be conducted for each step within the protocol.
- Conducting a meeting to introduce the planning protocol, develop a vision and objectives, and determine the BIM Uses. After the meeting, it can then be the responsibility of each working group to create the details of each BIM Use. After sufficient detail has been created, further meetings can be conducted in which the process, information, infrastructure, and personnel needs are defined.

Using either method, the Plan will communicate a standard organizational approach to BIM Uses, Processes, Information, Infrastructure, and Personnel, along will an advancement strategy to achieve the integration of BIM.

The Plan should have an established timeline. The timeframe should be broad enough to complete all the objectives, but also detailed enough that implementation can be planned. A typical time horizon is approximately nine to eighteen months. Additionally, the BIM Organizational Execution Plan should be reviewed on a regular basis, possibly at monthly or quarterly intervals and updated based on progress or changes to the objectives.

The Plan is a reflection of how the organization has integrated BIM to improve its operations. It should not develop into how the organization performs the tasks required to properly operate the facility. Also, any additional tasks that are a result of implemented BIM should not be included in the Plan.

3.1 Revisit BIM Vision and Objectives

The execution planning procedure revisits the goals and objectives, established in the strategic, to determine if the objectives are achievable within the timeframe of the Plan. The timeframe of the Plan is established within the BIM Roadmap and establishes objectives to accomplish within that timeframe.

While BIM may enable an organization to accomplish its goals, BIM itself is not the goal. Therefore, within the framework of the planning procedure, the mission and goals are specific to the organization, while the vision and objectives can be specific to the organization's BIM implementation. Thus, they are referred to as the Organizational Mission and Goals, and BIM Vision and Objectives. A brief description of each includes:

- **Organizational Mission**: Defines the purpose of an organization.
- **Organization Goals**: Specific aims which the organization wishes to accomplish.
- **BIM Vision:** The picture of the organization after it has integrated BIM.
- **BIM Objectives:** Specific tasks or steps that when accomplished move the organization toward their goals.

3.1.1 Evaluate the Mission of the Organization

As part of revisiting the BIM Vision and BIM Objectives, the integration of BIM is evaluated against the overall mission of the organization. Therefore, the first stage of establishing a BIM Vision and Objectives is to understand the mission of the organization or the purpose of the organization. A **mission** or **mission statement** defines *the purpose for the existence of an organization.*. A mission statement expresses an association's reason for being, conveys the association's identity, and articulates purpose, focus, and direction.[24]

When integrating BIM into the organization, the mission statement of the organization's facilities group is evaluated. Within an owner organization, there is the mission of the organization itself and the mission of the organization's facilities group.

CASE STUDY EXAMPLE: DoD Military Health System Mission

An example of this distinction is the US Department of Defense Military Health System (MHS). Its mission "is to provide health support for the full range of military operations and sustain the health of all who are entrusted to MHS care." While the mission of MHS's facilities group, Portfolio Planning and Management Division (PPMD), is to "serve as the focal point for all issues pertaining to the acquisition, sustainment, renewal and modernization of the full range of facilities within the Department of Defense (DoD) TRICARE Military Health System (MHS)[25]."

The BIM Organizational Execution Plan focuses on the mission of the facilities group. The mission of the facilities group is typically to support the mission of the entire organization. If the organization does not have a mission statement, the organization should determine and document the mission of the facilities group in one concise sentence or paragraph. The mission statement should focus on how those outside the organization to view the purpose of the organization[26], and contain four elements including purpose, strategy, behavior standards and values[27]. Once developed, the mission statement is documented in the BIM Organizational Execution Plan.

3.1.2 Establish a BIM Vision

Based on the mission of the organization, a BIM Vision is established for the duration of the Organization BIM Execution Plan's timeframe. The vision statement differs from that of a mission statement, in that a

[24] Drohan, "Writing a Mission Statement."
[25] MHS PPMD, "OCFO : PPMD : About PPMD," *OCFO : PPMD : About PPMD*, 2012, http://www.tricare.mil/ocfo/ppmd/about.cfm.
[26] Drohan, "Writing a Mission Statement."
[27] Andrew Campbell and Sally Yeung, "Creating a Sense of Mission," *Long Range Planning* 24, no. 4 (August 1991): 10–20.

vision statement is "*a picture of what an organization is striving to become*[28]". A vision statement pushes the organization to a future goal or objective, while a mission statement guides current decision-making. A Vision Statement is what the organization wants to be, or how it wants the world in which it operates to be. In this case, a BIM Vision Statement is the picture of the organization after it has integrated BIM, or how the organization envisions operating after integrating BIM. Lipton[29] stated that a vision should reflect the mission, strategy, and culture of the organization. The advantage of establishing a vision statement is that is creates a sense of direction for the organization. Lipton also states a vision can enhance a wide range of performance measures; promote change; provide the basis for a plan; motivate individuals; and help keep decision making in context.

An example of a BIM vision statement is, "We, XXX, undertake to make effective use of Building Information Modeling, BIM, in the lifecycle management of our facility – from design and construction to operation and maintenance, and beyond to decommissioning/disposal." If the organization already has a vision statement, which is likely, the organization will document how BIM enhances that vision and/or alters the vision. "*A shared vision can energize people by connecting them to the purpose of the organization or department."*[30] However, if the vision's principles are not reflected in the action of the organization, a vision hurts the organization's credibility.

3.1.3 Determine Organizational Goals

After the mission and vision of the Organizational BIM Execution Plan have been established, the organizational goals that will be accomplished during the course of the Organizational BIM Execution Plan are generated and documented. Goals, like the mission, are at an organizational level and are not necessarily specific to BIM; rather, they are specific aims, which the organization wishes to accomplish. The goal should not be to accomplish BIM, but rather an organization should strive to receive the benefits that may come from implementing BIM. Goals, often, provide a source of motivation and a reason why the organization is moving towards BIM implementation.

When establishing goals, they should be specific, measurable, attainable, realistic, and timely (S.M.A.R.T)[31]. A goal should give a sense of direction by focusing on specific targets and outcomes. Goals should establish the criteria by which the organization measures performance (quantitative if possible). The goals should be attainable or achievable based on the current state of the organization. In the same sense, goals should be within reach of the organization and while some might be a stretch, they should be realistic to achieve. In addition, goals should be timely, in that, they should be able to accomplish them in the set time frame of the execution plan.

Some example goals may include decreasing operational costs in the next year by 2% or decreasing the average amount of time spent on a work order by 10%. When developing goals for Organizational Execution Planning or any BIM Plan, they should be on the organizational level, but may be accomplished through BIM implementation.

[28] Drohan, "Writing a Mission Statement."
[29] "Demystifying the Development of an Organizational Vision," *Sloan Management Review* 37 (1996): 83–92.
[30] Lipton, "Demystifying the Development of an Organizational Vision."
[31] Doran, "There's a S.M.A.R.T. Way to Write Management's Goals and Objectives."

3.1.4 Form Clear BIM Objectives

In many cases, BIM allows for the accomplishment of organization goals. Therefore, specific BIM objectives need to be defined that are in-line with and lead to accomplishing the organization's goals. Objectives are specific tasks or steps that when accomplished move the organization toward their goals. BIM Objectives focus on the tasks and results that accomplish the organizational goals through the multiple BIM Uses.

Like goals, objectives should also be S.M.A.R.T., in that they are specific, measurable, attainable, realistic, and timely. Objectives are measurable and have completion criteria on which they are evaluated. Objectives can directly tie to the integration of a BIM Use within an organizational process. In contrast, an objective might be accomplished through multiple BIM Uses, or possibility no BIM Uses.

Some examples of BIM objectives for Owners are:

- Complete the organizational BIM execution plan
- Defining information needs for every operating unit of the organization
- Map all major organizational processes
- Use BIM data to automatically populate asset management system

CASE STUDY EXAMPLE: DoD Military Health System BIM Objectives

DoD Military Health System (MHS) has created nine specific BIM objectives for their organization[32]. They include:

1. Level of Detail (LOD). To clearly define the level of level of effort/detail (LOE/LOD) in the BIM and associated submittals.
2. Program for Design (PFD) Validation: To automate the validation of the contracted program requirements during the design process
3. Equipment Validation: To automate the validation of the medical equipment requirements during the design and construction process
4. Facility Management (FM) Integration: The focus of this goal is to automate the loading of new RPIE information into the FM module and more effectively coordinate the information needed from design and construction to support effective operations and maintenance of our facilities.
5. Equipment & Technology Management (E&TM) integration: The focus of this objective is to automate the hand-off of information through procurement and loading into the E&TM module effectively.
6. Energy: The primary focus of this objective is to use BIM to more effectively and efficiently support energy modeling of the design to allowing the team to make substantive sustainability (e.g. energy) decisions, support the MHS's ability to assess the performance over time and potentially support a degree of accountability towards energy independence.
7. Planning & Programming Analysis: Effective, relational and accurate data from requirements and design development, construction, transition and operations back to planning policy development.

[32] Russell Manning, "MHS Facility Life Cycle Management (FLCM) Building Information Modeling (BIM) Minimum Requirements" (Department of Defense Military Health System, May 21, 2011), http://www.tricare.mil/ocfo/_docs/BIM-UFC-RequirementDetails.pdf.

8. Initial Outfitting & Transition (IO&T) Support: Effectively integrate the transition planning and execution with planning and design development. This objective targets integrating the transition planning and initial outfitting (IO) procurement process more effectively with the design development and construction execution.
9. Interoperability: To achieve interoperability of Required Elements across the Facility Life-Cycle Management (FLCM).

3.2 Evaluate Internal BIM Uses

During this phase of the planning procedure, the organization determines how they will use BIM to improve their internal processes. This internal application of BIM is called a BIM Use. A BIM Use is defined as *a method or strategy of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives*. Additionally, the Level of Maturity of the BIM Use obtained after the completion of the execution plan is also documented. Table 3-1 shows an example of the BIM Uses within the operations phase of a facility along with the example maturity levels.

Table 3-1: Example of BIM Use Selection Results

X	BIM Use	Description	Current Maturity	Target Maturity
X	Data Commissioning	Facility data from a BIM Model is used to populate an organization's Facility Management System (FMS)	Non-Existent	Managed
X	Performance Monitoring	Monitoring the performance of the facilities including items such as energy, air quality, and security	Non-Existent	Defined
	Systems Control	Controlling elements or systems of the facility such as lighting, electrical, HVAC, and conveying	Initial	Initial
	Space Tracking	Monitoring the usage of spaces within the facility	Initial	Initial
X	Asset Management	Management of facility assets to ensure optimal value over its life cycle	Initial	Defined
X	Maintenance Management	Actions intended to retain facility elements, or restore facility elements to a state in which the facility element can perform its intended function	Non-Existent	Defined
	Condition Documentation	Recording the state of the facility	Initial	Initial
	Scenario Forecasting	Predicting possible situations within the facility such as crowd flow, evacuation procedures and other disasters	Non-Existent	Non-Existent

3.2.1 BIM Uses Maturity Levels

When adopting BIM into an organization, it is difficult to imagine that an organization will be able to optimize a use of BIM to its full maturity level within the time of the Organizational BIM Execution Plan. BIM Use Maturity level is the degree to which an organization excels performing a BIM Use. Therefore, the desired Level of Maturity for each BIM Use is selected to be achieved during the course of the execution plan. The Levels of Maturity, based on Capability Maturity Model Integration (CMMI) for

Services[33], include (0) Incomplete (1) Initial, (2) Managed, (3) Defined, (4) Quantitatively Managed, (5) Optimizing. Table 3-2 shows an explanation of the Level of Maturity of BIM Uses.

Table 3-2: Explanation of the Levels of Maturity of BIM Uses

Maturity Level	Description
(0) Non-Existent	At this maturity level, a process has not yet been incorporated into current business processes and does not yet have established goals and objectives.
(1) Initial	At this maturity level, a process produces results in which the specific goals are satisfied, however, they are usually ad hoc and chaotic. There is no stable environment to support processes with the inability to repeat such and possible abandonment in time of crisis.
(2) Managed	At this maturity level, a process is planned and executed in accordance with policy; employs skilled people having adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.
(3) Defined	At this Maturity level, a process is tailored to the organization's standard processes according to the organization's guidelines; has a maintained process description; and contributes process related experiences to the organizational process assets
(4) Quantitatively Managed	A this maturity level, a process is managed using statistical and other quantitative techniques to build an understanding of the performance or predicted performance of processes in comparison to the project's or work group's quality and process performance objectives, and identifying corrective action that may need to be taken.
(5) Optimizing	At this maturity level, a process is continually improved through incremental and innovative processes and technological improvements based on a quantitative understanding of its business objectives and performance needs and tied to the overall organizational performance.

Organizations should strive to achieve and sustain one maturity level before moving on to a more advanced level. It is not recommended that an organization try to obtain a high maturity level without first achieving the lower levels. Each advancement in maturity levels builds upon the foundation of the maturity level below it, which makes skipping levels challenging. However, with that said, it is possible to advance the BIM Uses maturity level several steps during the course of the execution plan's timeframe. This is done by using each of the maturity levels as a milestone and by moving through the maturity levels to accomplish the desire maturity level rather than attempting to skip right to the level.

3.2.2 Organizational BIM Uses for Owners

There are many ways in which BIM can be used to improve a facility owner's processes. The following, while not a comprehensive list, are specific methods that BIM can be utilized for one or more purposes that are specifically applicable to facility owners. In most cases, owners are already performing these items, however without the use of BIM. The integration of BIM and facility data within these tasks allow for more improved and often better processes. Some of the more critical BIM Uses include:

- **Data Commissioning:** A process in which facility data, such as part numbers, warranty information, from a BIM Model is used to populate an organization's facility management system (FMS) while ensuring the accuracy of the information and significantly reducing the data entry time.

[33] E. Forrester, B. Buteau, and S. Shrum, *CMMI® for Services: Guidelines for Superior Service* (Addison-Wesley Professional, 2011).

- **Performance Monitoring:** A process in which BIM can be used to assist in monitoring the preformation of the facilities including items such as energy, air quality, and security.
- **Systems Control:** A process in which BIM can be used to assist in controlling elements or systems of the facility such as lighting, electrical, HVAC, and conveying to name a few.
- **Space Tracking:** A process in which BIM is used to monitor the usage of spaces within the facility.
- **Asset Management:** A process in which BIM is used to assist in the management of facility assets to ensure optimal value over its life-cycle. These assets, consisting of the physical building, systems, surrounding environment, and equipment, must be maintained, upgraded, and operated at an efficiency, which will satisfy both the owner and users at the lowest appropriate cost to support financial decision-making as well as short-term and long-term planning. Asset categories can include personnel, space, equipment, systems, FF&E systems and components, IT and AV systems components and other data to be determined to be of value by each customer.
- **Maintenance Management:** A process in which BIM is used to assist in actions intended to retain facility elements, or restore facility elements to, a state in which the facility element can perform its intended function.
- **Condition Documentation:** A process in which BIM is used to assist in recording the state of the facility. This can be accomplished with a number of tools including but not limited to laser scanning, photo-geometry, and traditional surveying.
- **Scenario Forecasting:** A process in which BIM is used to predict possible situations within the facility such as crowd flow, evacuation procedures and other disasters.

For a more details visit: http://bim.psu.edu. The aforementioned list provides a snapshot of the BIM Uses currently available, but, as BIM continues to evolve the methods in which BIM is implemented will continue to expand and mature.

3.3 Design BIM-Enabled Process

To advance the processes of each work group, it is essential to first understand and document the current state of the processes. First the processes that will integrate BIM are mapped in their current state. Once the current processes are thoroughly document those that will become BIM-Enabled processes are mapped. These new BIM-Enabled operations should also be thoroughly document and shall be included along with the activities of the entire organization. It is important to note that unlike in the BIM Project Execution Planning Guide, the operations of a facility may consist of many repeatable processes.

3.3.1 Methods of Documentation

There are several methods that can be used to map processes. Some of the more commonly used methods include integrated definition (IDEF) with IDEF0 Functional Modeling, Unified Modeling Language (UML), and Business Process Modeling Notation (BPMN). Each process modeling technique has its own benefits and purpose; and one is not necessarily better than another. Each organization should select a standard to offer consistency throughout the organization. Most organizations already have a standard in place and should continue with that standard. The BIM Project Execution Planning Guide's maps are based on Business Process Modeling Notation. An explanation of symbols within that notation can be

found in the BIM Project Execution Planning Guide. Additionally, example process maps for a select number of the BIM Uses can be found on the project website (http://bim.psu.edu).

3.3.2 Document Overall Organizational Structure and Process

In the BIM Project Execution Planning Guide, planning teams mapped the entire lifecycle of the facility at an overview level from planning through operations. However, unlike a facility construction project, which typically has a finite beginning and end, operating a facility is a continuous process. Instead, facility operations consist of multiple different operating units that have defined tasks and responsibilities. It is these tasks and responsibilities that are documented.

There are several methods to accomplish documenting the organizational structure. In most cases, organizations have their structure already documented. This documentation may or may not include tasks and responsibilities. If an organization already has its structure defined with the necessary elements of task and responsibilities, it is simply updated to ensure that it is current. Another method to document organizational structure with tasks and responsibilities is to meet with each operating unit's manager and together determine the responsibilities of the unit. Additionally, the BIM Planning Team should be identified within this structure. It may lie outside the primary structure as its own operating unit or it may be integrated into multiple units. Once the structure has been identified, the BIM Uses selected by the organization should be integrated into the tasks and responsibilities of the operating units.

3.3.3 Current Processes

The tasks that will integrate BIM during the course of the Organizational Execution Plan are mapped to provide a basic understanding of the current task and to help with developing a transition process. The processes are documented through meeting with the head of each operating unit or meeting with the implementers of the process. Another way to document the process is through observation of the tasks. The process should also include the information exchanges between operating groups. After an observation or meeting, the process should be documented using a process mapping notation decided on by the group. After the process is documented, the process stakeholders should review and edit the document until it satisfactory represents the workflow of the organization.

3.3.4 Future Detailed Processes

Once the current processes are documented, the planning team, with the assistance of the operating unit members, is able to revise the current process map to include the integration of BIM. This will include replacing, adding, or editing processes within the map. The process map will also need to include any new or revised information exchanges.

3.3.5 Transition Plan for Each BIM Use

A detailed advancement/transition plan for each of the BIM Uses identified for advancement is created to allow for smooth transition between the current process and the new process. It is critical to identify the steps required to transition the process to a BIM-Enable process. The steps should include measureable outcomes and milestones with a timeline for the competition of each transition. Some items to be considered are purchasing software, training, setting-up new systems, creating process guidelines, and

progress checks. More tasks may need to be determined based on the status of the organization and the specific task, which is being transitioned. There are several ways to display this transition process including, for example, a process mapping notation, or a critical path method (CPM) schedule.

3.3.6 Overall Transition Plan for the Organization

After the detailed transition plan for each BIM Use has been documented, an overall transition map for the duration of the execution plan is created. This should include the adoption of each BIM Use at every level of maturity, along with other critical milestones. The transition plan should include a timeline for completion of the milestones and can be displayed using several methods including process mapping notation or a CPM schedule. The timeline should reflect the transitions in the process over the planning period.

3.4 Document Internal Model and Facility Data Information Needs

For each working group and process defined in the prior step, the geometric model and facility data requirements are to be defined and documented. The information requirements should then be summarized and complied into organizational information requirements. There are two primary items to be considered when determining information needs. These include the geometric model and facility data. The geometric model is an electronic, three-dimensional representation of facility elements with associated intelligent attribute data (facility data).[34] Facility data is non-graphical information that can be stored for objects within the geometric model that defines various characteristics of the element. Facility data can include properties or attributes such as manufacturing data, materials, and project identification numbers. It is important to consider both types of information when defining information requirements.

3.4.1 How to Determine Information Needs

Similar to how the processes were documented; the most comprehensive way to determine information needs is with by interviewing key stakeholder in each working group. This can be performed during the process documentation or at separate follow-up meetings. Alternatively, it is possible to have the BIM Implementation Team make an initial pass at the information needs using the information needs template available at http://bim.psu.edu.

If the organization has undefined information needs, the BIM Implementation Team may determine that it is more beneficial to adopt the information needs documented by other organizations. Organizations such as the DoD Military Health System, the US Army Corps of Engineers, Penn State Office of Physical Plant, and the Department of Veteran Affairs, along with others, have comprehensive information needs documented in their contract language, which is freely available.

To determine the information needs for the working group or organization, four primary questions should be addressed:

[34] USACE/Industry BIM Advisory Committee, "USACE MILCON Transformation RFP, Section 01 33 16 - Design After Award, Attachment F - BIM Requirements" (US Army Corps of Engineers, April 7, 2011), https://cadbim.usace.army.mil/BIM.

1. What building elements or other information (e.g., rooms and zones) are tracked and what additional formation would be beneficial to track?
2. What information is beneficial to be displayed graphically, in addition to the facility data?
3. What is the level of development necessary for each element of the Model to receive the benefit?
4. What are the properties or facility data about the building elements that need to be documented, including those that are currently tracked and those that would be beneficial to be tracked?

3.4.2 Choose a Model Element Breakdown Structure for the Organization.

To transfer information seamlessly from one application to another, information must be categorized according to a model element standard. To answer the four questions above for each operating unit, the BIM Implementation Team should use an element breakdown structure similar to the Information Needs Template. There are several different model element breakdown structures that can be used depending upon the granularity the organization wishes to document. The Information Needs Template, provided in the appendix of this guide and at http://bim.psu.edu, is based on an OmniClass[35] Table 21 – Elements breakdown structure; however OmniClass Table 22 – Work Results, and OmniClass Table 23 – Products are viable options along with CSI UniFormat[36] and MasterFormat.[37]

3.4.3 Determine Model Needs

Once a model element breakdown structure has been selected for the organization, the model needs of each facility element for each working group should be determined. This can be accomplished by stepping through each element of the facility data and determining if a visualization of that element would be beneficial to the working group.

3.4.4 Determining Level of Development

If a model element has been determined to be valuable to the working group, the working group then determines what Level of Development (LOD) is necessary to achieve the benefit for that specific model element. The Level of Development describes the level of completeness to which a Model Element is developed.[38] There are several ways that Level of Development can be documented. An indicator for the Level of Development, as found in the original BIM Project Execution Planning Guide and shown in Figure 3-2, can be used to represent geometric reliability.

[35] "OmniClass: A Strategy for Classifying the Built Environment," *OmniClass*, n.d., http://www.omniclass.org/.
[36] Construction Specifications Institute, "UniFormat™ 2010," 2010, http://www.csinet.org/Main-Menu-Category/CSI-Store/6/35152343-f0b4-df11-8ffb-0019b9e160b2.txt.
[37] Construction Specifications Institute, *MasterFormat 2012*, 2012, http://www.csinet.org/MasterFormat.aspx.
[38] American Institute of Architects, *E202–2008 Building Information Modeling Protocol* (Washington, DC, USA: The American Institute of Architects, 2008), http://www.aia.org/contractdocs/training/bim/AIAS078742.

Information	
A	Accurate Size & Location, Include Materials and Object Parameters
B	General Size & Location, Include Parameter Data
C	Schematic Size & Location

Figure 3-2: Example of Level of Development for BIM Project Execution Planning Guide

Another option to select is the Level of Development (LOD) defined in the model progression specification and adopted in AIA E202. This Level of Development is currently the most widely accepted breakdown in the industry. The descriptions are in the process of being updated, however Table 3-3 shows an example of the Level of Development descriptions. If possible, it is recommended that at a minimum an organization would select an industry standard.

Table 3-3: Level of Development Description [39]

Level of Development	Description
LOD 100 **Schematic Design Model**	Overall building massing indicative of area, height, volume, location, and orientation may be modeled in three dimensions or represented by other data.
LOD 200 **Design Development Model**	Model Elements are modeled as generalized systems or assemblies with approximate quantities, size, shape, location, and orientation. Non-geometric information may also be attached to Model Elements
LOD 300 **Construction Documentation Model**	Model Elements are modeled as specific assemblies accurate in terms of quantity, size, shape, location, and orientation. Non-geometric information may also be attached to the Model Elements.
LOD 400 **Construction Model**	Model Elements are modeled as specific assemblies that are accurate in terms of size, shape, location, quantity, and orientation with complete fabrication, assembly, and detailing information. Non-geometric information may also be attached to Model Elements.
LOD 500 **Record Model**	Model Elements are modeled as constructed assemblies actual and accurate in terms of size, shape, location, quantity, and orientation. Non-geometric information may also be attached to modeled elements.

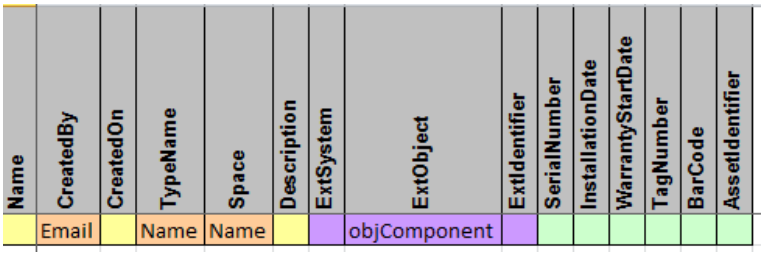
3.4.5 Determining Facility Data Needs

One item that the Level of Development does not specify is the facility data needed about each facility element. The facility data, attributes, and properties, should be specified about each element and even element not modeled may require facility data to be documented. There are several examples of the properties that need to be collected for each element. A few of these include the MHS Facility Life-Cycle Management (FLCM) Building Information Modeling (BIM) Minimum Requirements[40] and the object

[39] American Institute of Architects, *E202*, 202.
[40] Manning, "MHS BIM Requirements."

element matrix in the VA BIM Guide[41]. These examples, which vary in level of detail, can be used, as a basis for an organization facility data needs. Additionally, it is possible to specify facility data properties necessary using the items list in Omni-Class Table 49 - Properties.

Another option when selecting attributes and necessary facility data is to select necessary columns of the Construction Operations Building Information Exchange (COBie) worksheets. COBie is designed to enable information exchanges between data sources by providing a standard structure for facility data. It does not however specify what properties an organization needs to track and populate. This is up to the organization. Figure 3-3 shows an example the properties in the component tabs of COBie 2.26.



Name	CreatedBy	CreatedOn	TypeName	Space	Description	ExtSystem	ExtObject	ExtIdentifier	SerialNumber	InstallationDate	WarrantyStartDate	TagNumber	BarCode	AssetIdentifier
	Email		Name	Name			objComponent							

Figure 3-3: Example of the Components Tab Properties in COBie 2.26

3.4.6 Compile Organizational Information Needs

After both model needs and facility data needs have been determined for each operating unit, they should be compiled into a single list of information needs for the organization. This can be accomplished by selecting the highest Level of Development for each model element and by compiling the facility data elements. When compiling facility data elements, duplication of entries or terms for a property should be avoided. When choosing a standard term for the property, the term selected could originate from the OmniClass Tables or the COBie Spreadsheet when available, as these are becoming standards. Once all the information needs are compiled, they are used as a central structure for all the model and facility data information needs throughout the organization.

3.5 Determine Infrastructure Needs

Often, an organization begins with selecting the software and hardware when they begin to implement BIM, even before they determine the purpose and objectives of the software. The infrastructure needs should consider the BIM Uses, processes, and, information needs of the organization. The infrastructure needs an organization should consider include software, hardware, and physical spaces.

3.5.1 Selecting Software

Selecting the proper software is one of the critical factors to successful BIM implementation within the organization. There are many factors that should be considered when selecting software. Of these, it is important to always ask, "Does the software meet the needs?" Before purchasing and evaluating

[41] Dept. of Veterans Affairs, *The VA BIM Guide*, Version 1.0 (Washington, DC, USA: Department of Veterans Affairs, 2010), http://www.cfm.va.gov/til/bim/BIMGuide/lifecycle.htm.

software, an organization should know the purpose they are trying to accomplish with the implementation of that software. In this case, what BIM Use does this software support and how well does it support it.

3.5.1.1 Factors to Consider when Selecting Software Systems

Chan (1995) has defined the following factors for consideration when selecting software:

Table 3-4: Factors to Consider when Selecting Software Systems[42]

Variable	Factor
Software (technical)	-Availability of an integrated hardware/ software package -Compatibility with existing hardware/software -Ease of use/user-friendliness -Availability of source code
Software (non-technical)	-Price (initial cost and maintenance/upgrades) -Popularity
Vendor (technical)	-Technical support -User training -Technical skills -Experience of using products developed by the same vendor
Vendor (non-technical)	-Reputation -Business skills -References -Past business experience with the vendor
Opinions (technical sources)	-Potential vendors/sales representatives -In-house "experts" -External consultants -Public Reviews
Opinions (non-technical sources)	-Subordinates -End-users -Outside personal acquaintances

3.5.1.2 Types of Software Systems

Software needs to be selected to support the BIM Uses. The list of software packages that support BIM implementation is constantly shifting and growing. It is important that the organization knows what they need the software to support and keeps in mind that one software package may support multiple BIM Uses. However, it may not be possible to obtain all the organization's BIM objectives through one software package.

Four major categories of software systems to be considered for owner use include:

3.5.1.2.1 Facility Management Systems (FMS)

Facility Management Systems are software packages that support the maintenance and management of a facility. It helps to manage work orders, assets, inventory, and safety. Many packages include many more modules. Some names that can be classified under Facility Management system include

[42] P.Y.K. Chau, "Factors Used in the Selection of Packaged Software in Small Businesses: Views of Owners and Managers," *Information & Management* 29, no. 2 (1995): 71–78.

Computerized Maintenance Management Systems (CMMS), Computer-Aided Facility Management (CAFM), and Computerized Maintenance Management Information System (CMMIS). If an organization has a FMS, it should be evaluated for its ability to support the BIM Data and Uses as defined in the previous steps. If an organization does not have a FMS, it is important that the proper one is selected.

Some additional factors, other than the factors stated previously, to consider when selecting a FMS include [43]:

- **Standalone:** Is the system standalone or do extra software packages or modules that should be purchased? Some systems should be mounted on top of other systems or require the purchase of multiple modules.
- **Scope:** What are the services that the FMS provide? How does each service integrate? How does the FMS support the BIM Uses selected?
- **Integration with Legacy Data:** Does the FMS support the import and/or export of data to other systems. It is especially important to consider the integration and acceptance of BIM Data: Does the FMS have the ability to import and/or export BIM data directly from the BIM Model? Does the FMS support open standards for data transfer such as COBie, IFC BIM model and the information within the BIM Model directly within the FMS? How seamless is the integration? Also consider how the FMS handles other graphical data such as photographs and plans.
- **Vendor:** Does the vendor install and customize the software? Does the vendor handle upgrading legacy data? What is the software support and training program provided?

3.5.1.2.2 Design Authoring

Another common purchase for an owner is Design Communication systems. Design Communication systems support the BIM Uses of Model/Drawing Production, Design Reviews, 3D Coordination. The first question that must be asked, is this system necessary? If your organization does self-perform tasks, then it is most likely these systems will need to be purchased. However, if your organization simply reviews a Model provided by others, then most software systems provide a "free viewer" to view the model.

3.5.1.2.3 Facility Monitoring and Control

Facility tracking software systems help to track the performance of a facility in regards to environmental, HVAC, and energy monitoring, to name a few. It may be possible that these tools are integrated into a FMS. However, if not part of the current and future FMS, the organization should consider how they are going to monitor their facility. When purchasing facility tracking software systems, an organization should consider the ability to monitor additional new facility systems and the integration of the tracking systems.

[43] F. Booty, *Facilities Management Handbook*, Fourth ed. (Jordan Hill, Oxford OX2 8DP, UK: Elsevier/Butterworth-Heinemann, 2009).

3.5.1.2.4 Planning/Design/Construction Software Systems

The organization should also consider additional software systems for planning, design, and construction of facilities. These software systems should be considered when developing an organization's BIM Project Execution Plan Template. It is critical to consider what software is necessary to pull information from the FMS and the operation of a facility to improve future design. In addition, organizations should consider how the design and construction information will be able to support the operational systems if they have already been established.

3.5.2 Choosing Hardware

Not having the proper hardware to support the software systems can lead to challenges and frustration when implementing and integrating BIM within the organization. It is essential that the organization understands the hardware specifications of the computers on which BIM Models are created. If the owner does not match or exceed those specifications, the model and data created throughout design and construction may become unusable in operations. Also, it is important to ensure that the hardware supports the BIM Uses that were selected for the operation of the facility.

3.5.2.1 Interacting with Facility Data

The organization needs to consider how the end-users will interact with the data. This includes both the device and physical space. Three workstations types that need to be considered are mobile, fixed, and collaborative, each of which has its own benefits and drawbacks.

3.5.2.1.1 Mobile Workstations

If the end-user is mobile, it may be possible to access information via a smart phone, slate, or tablet devices. A number of software vendors supply mobile versions that can seamlessly access facility data from the cloud. These versions allow for ease of access of the facility data and the ability to update information in the location in which the task is being performed. Additionally, tablets and smart phones usually have a smaller learning curve than a personal computer.

3.5.2.1.2 Fixed/Semi-Fixed Workstations

If the end-user does not change locations often, consider a desktop computer. If there are occasions that the end-user has to relocate but can work at a desk consider a laptop computer. In either case, a personal computer usually affords the user more processing power and higher functionality of software. When selecting a computer the most critical specifications to consider are the processor speed, the amount of RAM, and the graphics card. Additionally selecting a large format display or multiple monitors may also allow for productivity improvements.

3.5.2.1.3 Collaborative Workstations

Additionally, how the end-users interact with each other must be consider when determining infrastructure needs. It may be valuable to develop collaborative spaces to allow for interacting with the data in larger group. First, the organization should consider the necessity of this space or if they already have a space that could be converted into a more collaborative environment. If the organization decides to proceed with the development of a new collaborate environment, they should consider a number of items. Firstly, the number of people the space should support, remembering that anything much larger

than 20 persons should be a presentation space rather than a collaborative workspace. Secondly, the display should be considered. Based on the size of the space, the number of people it supports and the primary purpose of the space, the display can be selected. Consider items such as large high definition televisions, interactive displays and large format projection, remembering that in any case resolution of the display is important. Also, do not discount the importance of the furniture.

3.5.2.2 Maintaining Facility Data

There must be a hardware backbone to support the interaction with the facility data. Two critical pieces of the backbone include the network and servers.

3.5.2.3 Infrastructure Management Plan

After the infrastructure has been determined, a plan should be generated on how that infrastructure will be maintained and upgraded when necessary. This includes developing a budget for the hardware and maintenance of that hardware.

3.6 Determine Personnel Needs

Having the proper personnel is one of the most critical factors to successful implementation and integration of BIM. When considering personnel, the BIM Implementation Team should consider the organizational structure, the different roles and responsibilities, the training and education, and how to manage change within the organization.

3.6.1 Organizational Structure

One of the first questions to answer when planning for implementation is "How is BIM going to be supported within the organization?" There are several options when answering this question.

3.6.1.1 Consultant

One option for how BIM is supported by the organization is hiring an outside consultant to handle the integration of BIM. This option is beneficial for those organizations that have little experience with BIM. However, it will require the consultant to learn about the processes of that specific organization to be most effective.

3.6.1.2 Within Working Group

A second option is to put the responsibilities of integrating BIM on those who will be implementing BIM themselves. The benefit of this option is that these personnel have the most experience with their own processes. Several drawbacks of this approach are that they may need a fresh approach to their processes to receive the most benefit from BIM and they will need to be allocated enough time to plan and implement BIM with the working group. This is difficult if they still maintain the same roles and responsibilities.

3.6.1.3 Separate BIM Implementation Team

A third option is to hire or develop an internal BIM personnel or team. With this option, the personnel should have a better understanding of the organization's processes; however, there will be expenses with educating and training of the team.

3.6.1.4 BIM Planning Committee

The best option may be a hybrid of the options. In the initial stages, a consultant may be hired to assist in the development of a strategic BIM Plan. From there, a BIM Planning Team can be established. The BIM Planning Team should consist of each of the option including BIM Champion(s), Management BIM Advocate, and Operating Unit BIM Leads. This cross-function leadership team needs to consist of members that are willing to learn to think outside traditional methods of operation. Additionally, while the committee members do not have to be the most senior members of the operating unit, they will have to speak for the needs of the entire unit and share the thoughts of the BIM Planning Committee with their operating unit.

3.6.2 Roles and Responsibilities

With a BIM Implementation Team established, the roles and responsibilities of each member of the team should be established and documented. This includes requirements and deliverables for each of the individuals on the team. Additionally, it may be beneficial these responsibilities to be divided amongst multiple individuals depending upon the organization's size and structure.

3.6.2.1 BIM Champion(s)

An organization should have at least one BIM Champion with a strong desire to implement BIM within the organization. A "BIM Champion" is *a person who is skilled and motivated to guide an organization to improve their processes by advocating for the adoption, managing resistance to change and ensuring implementation of Building Information Modeling*. It is their responsibility to take the planning process through to its conclusion and share its value with others to ensure that the proper amount of resources (time, personnel, and effort) is given to planning. Often these personnel will also support the actual implementation of BIM within the organization including developing BIM planning elements.

Responsibilities:

- Develop Organizational BIM Standards and Processes including contract language; and
- Oversee BIM implementation within the organization.

Capabilities:

- BIM expertise;
- Self-motivated individuals; and
- Easily adaptable to ever changing processes.

3.6.2.2 Management BIM Advocate/Sponsor

It is essential to have management buy-in to the concept of using BIM to improve operations to ensure a successful planning process. Establishing a BIM Sponsor at the management level of the organization is

often helpful to BIM implementation. Management must understand the resources necessary for successful BIM implementation including time, personnel, and effort and the ability to ensure that these resources are made available.

Responsibilities:

- Oversee BIM Planning Team; and
- Promote organizational BIM Adoption and Change.

Capabilities:

- Ability to provide financial support for BIM adoption;
- Basic understanding of BIM; and
- Understanding of organization's BIM goals and objectives.

3.6.2.3 Operating Unit BIM Leads

Within the BIM Planning Team, each primary operating unit of the organization should have a BIM Lead. The operating unit BIM Lead will provide valuable information to the BIM Planning about the operating unit's processes and information needs; will evaluate BIM planning results; will implement BIM with the operating unit. The operating unit BIM lead does not need to be the manager of that operation but should have influence within the operating unit and the support of the operating unit's manager.

Responsibilities:

- Document operating unit's processes and information needs;
- Validate BIM Plans appropriateness for operating unit; and
- Lead implementation and integration of BIM with the operating unit.

Capabilities:

- Significant influence within the operating unit;
- Detailed understand of BIM's impact on operating unit; and
- Training on BIM systems related that operating unit.

3.6.2.4 BIM Implementer

While not necessarily part of the BIM planning team, these are the personnel that will be using BIM on a daily basis to improve their processes. These personnel should assist the operating unit BIM Leads to help them better understand their processes, but understand that those processes may have to change based on the improvements provided by BIM. They will be required to have a basic understanding of BIM, and what it means for the organization. They will also need process specific BIM training to the specific software and processes that the implementer will be using. Both of these can be taught to the BIM Implementer after the planning procedure has been completed.

Responsibilities:

- Document operating unit's processes and information needs;
- Validate BIM Plans appropriateness for operating unit; and
- Lead implementation and integration of BIM with the operating unit.

Capabilities:

- Basic understanding of BIM;
- Understanding of BIM impact on the organization; and
- Process specific BIM training.

3.6.3 Training and Education

There are many different strategies related to both educating and training personnel about Building Information Modeling. While the definition of education and training are very similar, in this context the purpose of the instruction varies. Training is to teach so as someone becomes fit, qualified, or proficient in a specific task or process, while educating is to formally instruct about a subject – in this case BIM.

3.6.3.1 Education

Education is critical to helping an organization better understand BIM, and the organization's purpose for using BIM. It is important that an organization develops a consistent education program for the staff about the true capabilities of BIM; to educate the staff, but not oversell the capabilities of BIM.

An organization needs to determine what is important to convey through the various education mediums. A few examples of these items include:

- What is Building Information Modeling and how can BIM be use?
- What is the organization's purpose for BIM including mission statements and the Strategic BIM Plan?
- How BIM influences their role and responsibilities, and their processes?
- What are the organizational lessons learned and the resources available?

Like other forms of education, there are multiple levels of expertise required. The management of the organization may only need a basic introduction to BIM and what it means to the organization. While those who implement will need a much deeper understanding of what BIM is and how it can be used; along with how the organization plans to use it and how it influences their roles. Moreover, what are the lessons learned and where do they go for assistance. Depending on the organization's size, it may be possible to develop different education programs for each.

There are several different methods for education. These can include both items created internally and the use of external resources. Some of these methods include classes, webinars, videos, books, papers, and knowledge sharing resources. There are plenty of education resources available. Open resources can be used before the organization spends the effort to create their own priority education resources.

3.6.3.2 Training

In this context, train is to teach, so as to make fit, qualified, or proficient in a specific task or process, while educate is to formally instruct about a subject – in this case BIM. In most cases, BIM training will relate to a specific process or software system. Before any training takes place, a training strategy should be established. The training strategy should include (1) what to train on, (2) who needs what training, and (3) what are the methods to achieve the necessary training.

3.6.3.2.1 What to Train On

First, a list of the necessary training subject should be generated. These items include new and existing organizational business processes and procedures, and new and existing software systems.

3.6.3.2.2 Who Needs What Training

Remember that not everyone in the organization needs to be trained on every software system or business process. In most cases, it is only necessary to educate them on the purpose of an activity rather than on how to perform the activity themselves. In on most cases upper management needs only to be educated about BIM processes. Middle management, on the other hand, may need to have extensive education and only introductory training on different software systems. The implementers will need extensive education and training on the process and software systems, however the scope of their training and education may be much more focused. Remember it is possible to over-train. To maximize the organization's resources, including time, training should focus on the most important BIM Uses and their processes integration. Spending large sums of capital on multiple training sessions will quickly overwhelm the students and not allow them to apply what is being taught.

3.6.3.2.3 Training Methods

The methods of training, like education, can be both internal and external. Often a software vendor will provide training with the purchase of the software or for an additional fee. This may be necessary if no one in the organization has prior experience with the software. The training itself can take place in a classroom setting or on a website with tutorials. The training needs of the organization will vary based on size of organization and scope of the BIM adoption. It is up to each organization to determine to what extent and by what method are both education and training are necessary.

3.6.4 Managing Change

The key to managing change within the organization and adoption of BIM is to provide motivation to the employees. There needs to be a reason to change. In recent years, it has seemed that this change is driven by the fear of losing a job. Rather the motivation should be the increase in efficiency of the organization, which will allow the employees to do more beneficial tasks.

3.7 Developing a Business Case for BIM Integration

For most organizations, a Business Case is necessary to gain support for and to justify an investment in BIM. An effective Business Case is a multi-purpose document that generates the support, participation and leadership commitment required to transform an idea into reality. The Business Case does not focus on the details of the implementation of BIM, nor detail contract language, but rather is focused

specifically on the business drivers to consider when investing in BIM. The creation of the Business Case draws from many different parts of the organization's BIM Planning efforts including strategic planning, execution planning, and procurement planning. The Business Case should present justification for funding the BIM efforts that accomplish the organization's mission and goals. It is important for the Business Case to show how BIM is used to overcome problems within the organization and illustrates how the outcomes are accomplished. The Business Case examines the impacts, risks, cost, and benefits of a major shift in the organization.

The development of a Business Case, just like the other plans, is a collaborative effort. The BIM Planning Team including representatives from the operating units affected creates the Business Case. A Business Case for BIM includes the following items (at a minimum):

- Cover Page
- Executive Summary of Business Case
- Table of Contents
- Introduction and Background
- Business Drivers and Problem Statement
- Desired Business Goal(s) and Objectives
- Proposed Uses
- Cost / Benefit Analysis
    - Estimated Benefits and Metrics
    - Cost Estimates
    - Risk Assessment
    - Assumptions
- Implementation Timeline
- Final Recommendations
- Appendices

The proper amount of time needs to be devoted to developing the Business Case. A general rule of thumb states that development of the Business Case should take approximate five to ten percent of the anticipated implementation / transition time.[44] However, in this case some of that time may be used for other BIM planning efforts. The length of the Business Case should be kept to the minimum necessary for a clear and concise understanding of factors weighing into the decision whether or not to implement BIM.

3.7.1 Cover Page

The cover page of the Business Case includes the title of the report, the organization's name, and the date of the report.

[44] Oregon Department of Human Services, "Guidelines for Developing a Business Case & Business Case Template," March 2006.

3.7.2 Executive Summary

The executive summary of the Business Case provides a concise overview of the proposed BIM implementation and answers the question of why it should be supported. The executive summary allows readers to quickly become acquainted with the contents of the Business Case. It is intended to aid the decision makers within the organization. An executive summary of the Business Case for BIM Integration includes:

- The background of the BIM Planning process,
- The vision and objectives of BIM Implementation with organization,
- The proposed Uses of BIM with the organization,
- A cost/analysis summary of the BIM implementation, and
- Outlines recommendations.

The executive summary is written using short and concise sentences and paragraphs. It is no more than two pages in length. It is written in the same order as the Business Case and provides conclusions for the reader.

3.7.3 Table of Contents

A table of contents allows readers of the document to quickly locate all topics within the Business Case.

3.7.4 Introduction & Background

The introduction gives the background of BIM within the organization. Additionally, it includes a background on the organization itself. It discusses the mission and vision of the organization and its implementation of BIM. If the organization has used BIM in the past, even at a pilot level, it is summarized here.

3.7.5 Business Drivers and Problem Statement

The business drivers are the forces and pressures that have significant influence on how the business performs and operate.[45] The business drivers can be internal or external to the organization. Internal drivers could include efficiencies, collaboration, resources, and risks;[46] and also finances, technological capacity, organizational culture, and employee morale. External drivers include competition, industry outlook, economy, politics, and technological changes, to name a few.

The business drivers are then reflected within a Problem Statement. In his book, "The Six Sigma Revolution: How General Electric and Others Turned Process into Profits," George Eckes writes that a Problem Statement states the issue that the organization wants to improve or overcome.[47] These issues

[45] David Heise, "Business Drivers," *Data Warehousing Dictionary*, September 2, 2002, http://dheise.andrews.edu/leadership/comps/5b/3dw_kpi/dictionary.htm.
[46] Guillermo Aranda-Mena et al., "Building Information Modelling Demystified: Does It Make Business Sense to Adopt BIM?," *International Journal of Managing Projects in Business* 2, no. 3 (2009): 419–434.
[47] George Eckes, *The Six Sigma Revolution: How General Electric and Others Turned Process Into Profits* (John Wiley and Sons, 2002).

often tie directly to the business drivers. Eckes states that most problem statements relate to the finances of the organization in some form or fashion. According to Eckes, a good problem statement should include a time period, be specific and measurable, describe the impact on the organization, explicitly state the gap between current state and the future state, and contain only neutral terms. Creating a problem statement allows the organization to better understand the specific issue that the organization is trying to overcome through the use of BIM.

3.7.6 Desired Business Goals and Objectives

The Business Case should document the organizational goals and the BIM Objectives. In the "Modern Organization," Amitai Etzioni defines an organizational goal as 'a desired state of affairs which the organization attempts to realize.'[48] Organizational goals should share the state to which the organization is moving towards[49] and are a general statement of anticipated outcomes. Goals provide guidelines, legitimacy, motivation, and standards for the organization.

Goals should be supported by well-stated objectives. Objectives are specific tasks or steps that when accomplished move the organization toward their goals. In this case, the tasks should be accomplished through the use of BIM processes. In general, goals are usually more global in scope than objectives.[50] Both goals and objectives are necessary to support a business case for BIM.

3.7.7 Proposed Uses

The proposed Uses of BIM are documented in the Business Case. A BIM Use is *a method or strategy of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives*. The goals closely relate to the objectives and the tasks of the organization. Often, organizations already perform a task to accomplish the objective of the BIM Use, but without the benefit of BIM.

3.7.8 Cost / Benefit Analysis

The implementation of BIM should be considered an investment into an organization's future. Just like any investment, a cost benefit analysis should be performed to ensure that it is a sound investment. A cost benefit analysis sets the financial and non-financial cost of implementing BIM along with the anticipated benefits. The cost-benefit analysis also shows the anticipated return of implementing BIM.

The analysis answers the following questions:

- What are the benefit / income from BIM?
- What are costs of implementing BIM? This includes both initial and long-term costs. It should also include a possible funding source for the investment.
- What are the major risks associated with BIM implementation?

[48] A. Etzioni, *Modern Organisations* (Prentice-Hall Englewood Cliffs, NJ, 1964).
[49] Edward Gross, "The Definition of Organizational Goals," *The British Journal of Sociology* 20, no. 3 (1969): 277–294.
[50] "Glossary of Terms," n.d., http://www.csn.edu/pages/2820.asp; "Grants Office - Grant Resources-Glossary - Pasadena City College," n.d., http://www.pasadena.edu/externalrelations/grants/glossary.cfm.

- What are the major assumptions of this analysis?

3.7.8.1 Estimated Benefits and Metrics

A benefits analysis specifies the expected financial and non-financial returns from a given project. It compares 'with' and 'without' situations. The results of this analysis can be used to evaluate alternative options. It can strongly support a bid for management endorsement and resource allocation.

Some potential benefits that should be calculated based on the organization's planned implementation are:

- Improved project outcomes such as lower cost and shorter duration for project execution
- Streamlining of processes / reduced process time
- Improved quality of information
- Improved interoperability of data
- Reduced human error
- Reduced data entry time
- Centralization of information

3.7.8.2 Cost Estimates

The budget should include all identifiable costs to the organization, including staffing, software, legal, media, travel, physical resources, etc. The source of the funds should also be considered; is it an existing available fund or are new and additional funds required?

Some items to consider include:

- Cost for Planning:
  - BIM Champion(s) (percentage of time allocated * salary for allocated timeframe)
  - Planning Team Costs (percentage of time allocated * number of personnel * salary for allocated time frame)
- Personnel:
  - New / reallocated personnel ($/year including taxes and benefits)
  - Education and Training Cost ($/course necessary)
  - Miscellaneous Expenses (travel budget, etc.)
- Infrastructure
  - Software
    - Software Purchase($/license)
    - Software Maintenance Fees ($/license/year)
  - Hardware
    - Workstations ($/workstation including accessories)
    - Hardware Infrastructure ($/infrastructure item)
    - Infrastructure Maintenance Costs ($/year)
- Process Change Costs
  - Inefficiency Expenses (if applicable)
  - Learning Curve

3.7.8.3 Risk Assessment

Performing a risk assessment is critical when developing a Business Case for BIM. Like other changes in work process, the integration of BIM within an organization has risks. Table 3-5 shows an example of how the risk assessment summary may look. The steps of creating a BIM risk assessment include:

1. Risk identification
2. Risk evaluation including likelihood and impact
3. Risk mitigation
4. Risk summarization and recommendation
5. Risk assessment review and update

Table 3-5: Risk Assessment Table

Risk	Risk Likelihood	Risk Impact	Risk Mitigation Measures	Recommendation
	Low	Low		Acceptable
	Medium	Med		Not Acceptable
	High			

3.7.8.3.1 Risk Identification

There are a number of risks that need to be considered when planning the implementation of BIM within an organization. Some of risks of Implementing BIM include:

- Lack of Stakeholder Participation [51]
- Legal Concerns [52]
- Security of BIM Data
- Model Management is too Demanding [53]
- Lack of Standards [54]
- Lack of Interoperability
- Data Ownership [55]
- Data Accuracy [56]
- Learning Curve
- Cost Overruns
- Schedule Overruns

[51] Chuck Eastman et al., *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors* (John Wiley & Sons, 2011).
[52] Eastman et al., *BIM Handbook*.
[53] Eastman et al., *BIM Handbook*.
[54] Eastman et al., *BIM Handbook*.
[55] S. Azhar, M. Hein, and B. Sketo, "Building Information Modeling (BIM): Benefits, Risks and Challenges," *Mc Whorter School of Building Science, Auburn University, Alabama* (2010); Eastman et al., *BIM Handbook*.
[56] Azhar, Hein, and Sketo, "Building Information Modeling (BIM)."

This list is just a starting point for the risks associated with BIM implementation. Risks should also include the risks associated with not implementing BIM. Organizations should identify risks that are particular to their organization and circumstances.

3.7.8.3.2 Risk Evaluation

The identified risks are then evaluated based on the likelihood of occurrence and impact of the occurrence. Each area is given a grade of low, medium, or high based on the likelihood the risk will occur and the impact if the risk does occur.

3.7.8.3.3 Risk Mitigation

After the risks have been evaluated and identified, possible risk mitigation measures are determined for each of the risks identified.

3.7.8.3.4 Risk Summary and Recommendation

After the risks have been identified, evaluated and possible mitigation measures have been determined, the risks are summarized, and final recommendations are made whether the risks are at an acceptable level for the organization.

3.7.8.3.5 Risk Assessment Review and Update

Just like other BIM plans, the risk assessment and Business Case are periodically revisited and updated based on the ever-changing circumstances of the organization and the evolution of BIM.

3.7.8.4 Assumptions

Currently, there is little data on the cost and benefit of implementing BIM within an owner organization. Therefore assumptions of the cost and benefit analysis must be documented. Each item is listed in this section.

3.7.9 Implementation Timeline

The implementation timeline is an overview of the transition plan to building information modeling. It should include milestones and major objectives if the organization moves forward with BIM implementations

3.7.10 Final Recommendations

The final recommendations include the conclusions that can be drawn about the Business Case for the implementation of BIM within the organization. The recommendations should include the key factors that need to be considered when determining the validity of the Business Case. It can also include highlights from the other sections of the document to support the Business Case for BIM

3.7.11 Appendices

Appendices include information that supports the Business Case for BIM with the organization. This information is often too detailed for the body of the Business Case, but is necessary for the analysis. It also helps to show the level of effort that went into creating the Business Case. The appendices could

include items such as the strategic plan, the organizational execution plan, a project execution plan, procurement documents, detailed financial analysis, definitions of terms, and other documents to support the Business Case.

3.8 Recommendations for Organizational BIM Execution Planning

Throughout the planning process, the elements of the execution plan need to be documented in a central location to which all of the organization has access. There are several purposes for this. They include providing openness about the transition process, providing resources for the organization to use, and more importantly providing objectives for the organization to work towards. The plan could be documented in a static document. However, it may be better to have it on a website or organization wiki site that can be modified and updated as the organization modifies its Organizational Execution Plan. Remember that the organization execution plan set forth is a living document and may need to be adjusted as BIM technology and the organization evolve.

4 Owner BIM Project Procurement Planning

To procure BIM services on a project, it is important that the owner develop a clear procurement strategy including BIM contract documentation. These documents establish the requirements and therefore the direction of the project before design or construction begins. To accomplish this successfully, it is critical to plan and determine the BIM needs for the project. This section addresses many of the issues an owner may wish to consider when planning for procuring BIM services.

Prior to the start of any new project, the owner typically develops or updates the contract documentation for the upcoming project. This procurement language is necessary to ensure that the owner's needs are met, and the project team understands the scope and detail of the requirements to which they are agreeing. Having the BIM requirements documented prior to the start of the project allows the team to begin the BIM process earlier and more effectively.

There are three areas in which an owner can emphasize when planning BIM procurement documentation. As shown in Figure 4-1, the categories are Team Selection, Contract Procurement, and Project Execution. While these three areas the following project documents can be addressed: request for qualifications, request for proposals, BIM contract requirements, and BIM Project Execution Plan.

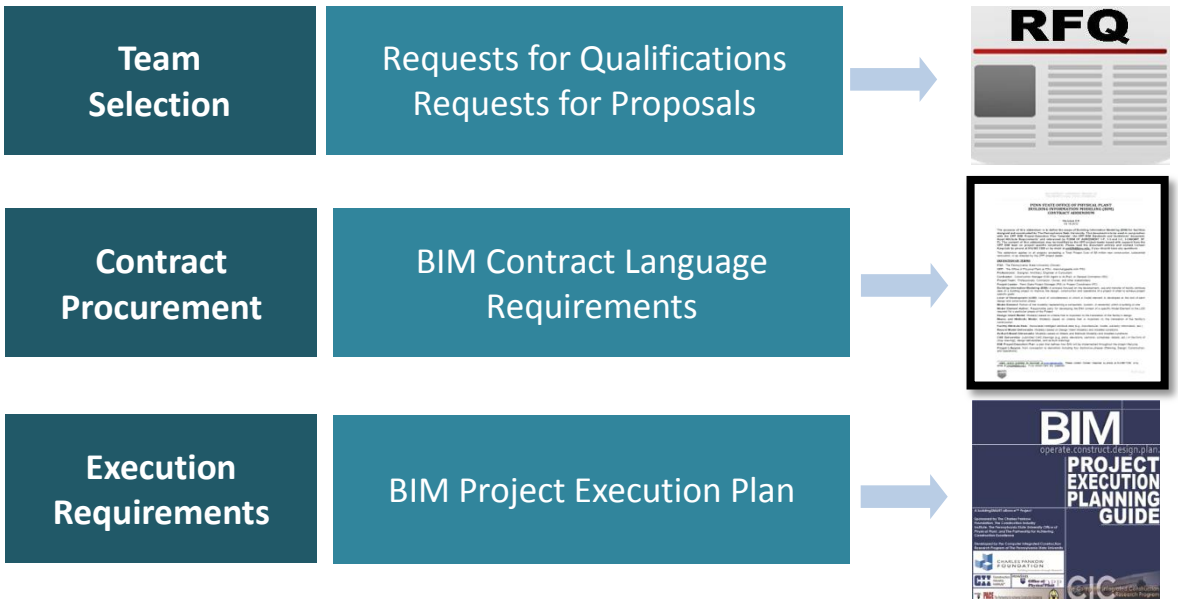


Figure 4-1: BIM Procurement Categories

Selecting the proper team sets the foundation for a successful BIM project. To accomplish this, the RFQ and RFP must contain adequate BIM language to enable owners to select project team members possessing the necessary skills. As Figure 4-2 indicates, the two documents should complement each other. The contract requirements typically specify high-level BIM requirements for the project while

leaving project specific requirements such as processes, individual responsibilities, and collaboration procedures to the BIM Project Execution Plan.

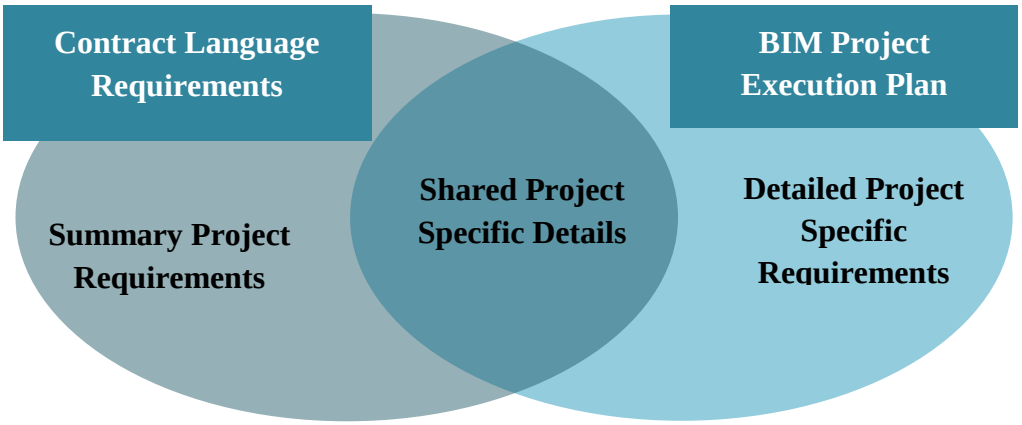


Figure 4-2: BIM Contract Requirements and Standard BIM Project Execution Plan Template Requirements

4.1 Prior to Developing Procurement Documents

Before an organization begins to develop BIM procurement documentation, it is beneficial to consider the general format of the contract and how BIM requirements may affect it. The BIM contract requirements can be incorporated into the existing design and construction contracts, or can be included as an addendum. For many small owners, it may be beneficial to include the BIM requirements into the existing contract in an effort to simplify the documentation. For larger owners who build on a frequent basis using standard contracts, it may be more beneficial that the Contract Requirements be added as an addendum for the following reasons:

1. BIM is constantly evolving resulting in frequent updates and modifications to the BIM contract requirements. Structuring the BIM contract requirements as an addendum may simplify the update process.
2. The same addendum can be included in the design, construction, and prime contract. Using the same addendum for all project participants is beneficial because it minimizes the risk of discrepancies between documents and increases the transparency of each participant's responsibilities.

When creating the requirements for each project, owners should require only the aspects of BIM which add value to the organization, because additional items may add unnecessary risk and cost to a project. It is often beneficial to become familiar with existing industry BIM Requirements, including how the organization's procurement method affects the contract and how the documents complement each other.

4.1.1 Existing BIM Contract Language Examples

There are numerous BIM procurement language examples, which an owner can reference when creating their own procurement language. The two industry standards are:

1. American Institute of Architects (AIA) E202 BIM Protocol[57]
2. ConsensusDOCS 301 BIM Addendum [58]

These documents were created as a means of providing BIM users with sample contract language to reference when creating their own documents. Each document takes a different approach to implementing BIM and many owners find it beneficial to include elements from both into their customized BIM contracts.

There are also numerous custom created documents, which are available for reference:

1. Penn State BIM Addendum V2.0 and BIM Execution Plan Template[59]
2. USACE Attachment F[60] and BIM Project Execution Plan Template [61]
3. Indiana University BIM Guidelines and Standards[62]
4. State of Ohio BIM Protocol [63]
5. VA BIM Guide [64]
6. Los Angeles Community College BIM Standards and BIM Standard Template [65]

These have been created by facility owner organizations who wish to further specify their BIM requirements. Many of these guides have already incorporated concepts from both AIA E202 and ConsensusDOCS 301 into their language, and have also added customized BIM language specific to their organization's BIM needs.

4.1.2 BIM in Different Procurement Methods

For BIM to reach its greatest potential, it is necessary for the project participants to work in a collaborative manner, openly working together and sharing information. Due to legal and situational restrictions, it is often necessary to procure projects using traditional organizational structures, contracting approaches, and selection methods such as Design-Bid-Build (DBB), Design-Build (DB), or Construction Management (CM). Although these delivery methods may restrict the collaboration in the project, if contracted properly, BIM can be implemented successfully in many different delivery methods.

[57] American Institute of Architects, *E202*.
[58] ConsensusDOCS, "ConsensusdDOCS301 BIM Addendum" (ConsensusDOCS, 2008).
[59] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum" (PSU OPP, December 2010), http://www.opp.psu.edu/planning-construction/design_and_construction_standards.
[60] USACE/Industry BIM Advisory Committee, "Attachment F."
[61] USACE/Industry BIM Advisory Committee, "USACE BIM PROJECT EXECUTION PLAN (USACE PxP)" (United State Army Corps of Engineers, 2010), https://cadbim.usace.army.mil/BIM_Files/USACE_BIM_PXP_TEMPLATE_V1.0.pdf.
[62] Indiana University, "Indiana University Building Information Modeling (BIM) Guidelines and Standards for Architects, Engineers, and Contractors" (Indiana University, 2009), http://www.indiana.edu/~uao/IU%20BIM%20Guidelines%20and%20Standards.pdf.
[63] Ohio State Architects Office, "State of Ohio Building Information Modeling (BIM) Protocol" (Ohio General Services Division, September 29, 2010), http://das.ohio.gov/LinkClick.aspx?fileticket=VD8N3VDCjno%3D&tabid=305.
[64] Dept. of Veterans Affairs, *VA BIM GUIDE v1.0*.
[65] Los Angeles Community College District, "Building Information Modeling (BIM) Standards," November 2011, http://standards.build-laccd.org/cgi-bin/projects/dcs/extensions/viewer/code/viewer_client.pl?command=MANUAL_INDEX.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

Penn State University's Physical Plant is often required to procure projects using traditional delivery methods such as DBB with a CM. To foster collaboration between all the project participants, they hire the CM for preconstruction services and require all parties involved to agree to the same BIM contract addendum and Project Execution Plan. This makes it clear what Penn State expects from the project team, and what the project participants can expect from each other. Even though the primary contract creates no responsibility toward the other project participants (privity), the collaboration expectations written in the addendum and the Project Execution Plan are clearly documented, thus encouraging the collaboration necessary for a successful BIM project.[66]

4.1.3 Hierarchy of Documents

It is important to define a hierarchy of documents within the contract requirements (if not already included in existing documents). The hierarchy prioritizes the documents in the event they conflict. It is important to note that in most contracts, the BIM model is not the "contract document;" therefore, it may be difficult to prioritize it ahead of Two-Dimensional (2D) documents in some situations. An example hierarchy can be as follows:

1. BIM Project Execution Plan
2. BIM Contract Requirements
3. Primary Contract Requirements
4. Submittals
5. BIM Model
6. 2D Documents

4.1.4 Minimum Project Size

Detailed implementation of BIM on every project is not always the most prudent decision depending on the project. Each project should be analyzed individually prior to the decision to use BIM. Many owners choose to set a minimum limit for which BIM is to be implemented based on size, scope, and cost of the facility. This provides a minimum threshold for BIM implementation, but still grants an owner the flexibility to choose on each project.

[66] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

Typical reasons an owner chooses to implement BIM on a project:

- It is an expensive building and the efficiencies gained through BIM are greater than the cost of implementing BIM Uses.
- The building has complex systems that would be difficult to construct without BIM.
- The owner desires to use the BIM model and information from construction for operations and maintenance.

Typical reasons an owner chooses not to implement BIM on a project:

- The project is a small renovation and modeling the existing facility would add significant cost without providing an equal or greater benefit.
- The local project teams are not capable of implementing BIM.

4.2 Request for Qualifications

The Request for Qualifications (RFQ) is the first tool an owner has for determining the BIM experience of potential project team members. After the RFQs are reviewed, the owner should be able to determine:

- Competence of the firm and its personnel with the BIM based on minimum BIM requirements;
- Ability of the firm and its personnel to meet minimum BIM requirements;
- Ability and willingness to collaborate and share information with other firms;
- Experience in BIM Project Execution Planning;
- Standard BIM Uses implemented on typical projects; and
- Technical Capabilities when developing BIM.

When analyzing the submitted RFQs, it is often helpful to use a scoring matrix similar to that shown in Table 4-1. Although it is sometimes difficult to determine the specific skills and capabilities of an organization and the potential team members, using a matrix assists the owner in organizing the submissions into a quantifiable score that can quickly and easily be ranked may help.

.

Table 4-1: BIM Qualifications Scoring Matrix

Category	Description	Level of Maturity						Score	Possible
		0	1	2	3	4	5		
BIM Project Execution Planning Experience	Experience the team has with planning for BIM on projects	Team has no experience with BIM planning on a project	Team has completed discrete BIM Uses but has not composed a BIM plan	Team has assisted in BIM Planning with other teams	Team has led BIM planning on projects	Team has integrated BIM planning into standard operating procedures	Team has developed a standard BIM Execution Plan to use on projects	1	5
Collaboration Experience	Willingness of the team to collaborate with others and their experience collaborating	Team has not collaborated with other teams and does not encourage collaboration	Team has collaborated on previous projects, but is not willing to share model/information fluidly	Team has experience and is willing to share information with other team members	Team leads collaboration efforts and encourages information sharing among parties	Team is willing to co-locate for a project	Team encourages co-location on all projects	2	5
BIM Tools	Competence of the project team in implimenting various BIM tools	Team has not implimented BIM and is not willing to do so	Team has not implimented BIM, but is willing to	Team has implimented BIM to a limited extent	Team has implimented BIM on many projects if required by the owner	Team impliments BIM tools on all projects	Team encourages all parties to impliment BIM tools on all project	2	5
Technical Capabilities	Ablities of the organization to preform BIM	Team does not impliment BIM or any other electronic technology	Team does not impliment BIM but utilizes limited electronic communication tools	Team does not impliment BIM but extensively uses electronic communication tools	Team Uses BiM to a limited extent and electronic communication tools	Team impliments cutting edge technologies on projects	Team is innovative in developing new technologies and BIM uses	1	5
TOTAL								6	20

It is important to require proof of qualifications as many will exaggerate their expertise in order to win a project. To filter through exaggerated BIM qualifications, an owner can ask questions such as the following:

1. Describe how your firm plans to use BIM on this project including proposed BIM Uses, processes, information exchanges, and collaboration procedures.
2. Provide an example of a project(s) in which you previously implemented BIM. Provide the following information for each project:
    a. Project Name
    b. Building Type
    c. Brief Project Description
    d. Project size and value
    e. Location
    f. Completion Date
    g. Description of value added through BIM implementation
3. Provide a completed BIM Project Execution Plan for project mentioned in item 2.If no BIM plan was used, provide detailed description of how BIM was used in project. Be sure to include roles and responsibilities, BIM Uses implemented, collaboration between project participants, and deliverables. Requiring a BIM plan within the qualifications/proposal submission greatly increases the size of the submission, but provides the owner with important evidence as to the true qualifications of the project team.[67]
4. Describe standard BIM practices on typical projects

4.3 Request for Proposal

The Request for Proposal (RFP) can provide the owner with a price and description of the proposed BIM Uses to be performed. The RFP should achieve the following:

[67] PSU Applied Facilities Research Group, "Psu Opp Rfq/rfp" (PSU OPP, 2011).

- Request a price for the proposed services to be performed;
- Request a description the proposed BIM Uses, collaboration procedures, and deliverables; and
- Request a description of the BIM project team and their qualifications.

A sample of the proposal scoring matrix is shown in Table 4-2. Much like the matrix provided for ranking the qualifications of applicants, the BIM Proposal Scoring Matrix provides the owner with the ability to rank the proposals based on the BIM services of greatest importance, and identify deficiencies in proposals prior to any contract award.

Table 4-2: Proposal Scoring Matrix

Category	Description	Level of Maturity						Score	Possible
		0	1	2	3	4	5		
Price	What is the total price for the listed services	Price is significantly different from the estimated price	Price is significantly higher than estimated price	-	Price is close to estimated price	-	Price is lower than estimated price but still within acceptable range	1	5
Additional BIM Uses	What additional BIM services are proposed	Many Required BIM Uses are not included in the proposed	A few required BIM Uses are not included in the proposal	-	All required BIM Uses are included in the proposal	-	Required and additional BIM Uses (with added value described) are included	3	5
Project Team Qualification	How much experience and success has the proposed project team had	None	Team has had minimum success with BIM projects	Team has limited experience and success with BIM projects	Team has adequate experience with BIM projects	Team has significant experience with BIM projects	Team has expert experience with BIM projects	1	5
Collaboration Procedure	What collaboration procedure is included in the proposal	No collaboration procedure described	Team proposes a basic collaboration procedure	Team has developed a BIM Execution plan detailing collaboration	-	A detailed BIM Execution plan including a collaboration procedure is proposed	A detailed BIM Execution Plan including a collaboration procedure is proposed for every team member including onsite collaboration	2	5
Deliverables	What are the deliverables proposed	Minimum deliverables are not met	Some of the minimum deliverables are met	Most of the minimum deliverables are met	All of the minimum deliverables are met	All of the minimum deliverables are met and additional ones are proposed	All of the minimum deliverables are met and additional ones are proposed with a value added description	3	5
Total								10	25

To score the proposals accurately, the owner should provide a detailed description of the services they expect to be provided. This description is often provided through the Contract Requirements and the Project BIM Execution Plan Template. In addition, it to explaining the requirements, it is also helpful to inquire about the project teams BIM experience and skill in BIM. Potential BIM RFP questions may include the following:

1. Describe the BIM Use your organization proposes to provide on this project. This should include proposed BIM Uses, collaboration procedures, and deliverables.
2. Who is the BIM Manager for the proposed project?
    a. How many BIM projects has he/she managed?
    b. What were the budgets for the projects?
    c. What BIM Uses has the BIM manager implemented?
3. Provide the total cost for the contracted services.

4.4 BIM Contract Requirements

The BIM contract requirement for projects is intended to document the standard BIM requirements of the owner organization. This document focuses on standard project goals and BIM objectives of the organization, while the BIM Project Execution Plan will contain much of the project specific BIM requirements. The document should complement the Typical BIM Project Execution Plan, as they are intended to work together to create complete documentation. In many situations, topics will be introduced in the contract requirements, but will reference the BIM Project Execution Plan for project specific details. The elements of the BIM Contract Language include:

- Definition of Terms
- BIM Project Execution Plan
- BIM Champion
- Collaboration
- Minimum Deliverables
- Ownership of Data
- BIM Requirements for 2D Documents
- Security

4.4.1 Definition of Terms

Many BIM terms have different definitions depending on the people utilizing them. Unless the owner provides a detailed description of their specific meaning of the term potential disputes may arise. Providing standard organizational BIM definitions removes any ambiguity in expectations. Potential terms to describe are:

- Model
- Building Information Modeling
- Building Information Model
- BIM Project Execution Plan
- As-Built Model
- Record Model
- Federated Model
- Level of Development
- Integrated Model
- Design Model
- Co-Location
- Fabrication Model
- Professional
- Contractor
- Project Team
- Subcontractor/Prime
- BIM Use
- Level of Development
- Facility Data

A detailed description of each BIM Use should also be defined prior to beginning a project. These Uses are most appropriately defined within the BIM Project Execution Plan.

4.4.2 BIM Project Execution Plan

It is helpful for the owner to require the typical BIM Project Execution Plan template to be the foundation for the project plan as it will already contain most of the necessary owner specified information and requirements. The plan should be developed from the template by all project participants at the earliest stage of each member's involvement in the project. After completion, the BIM Project Execution Plan is often approved by the owner and submitted as an addendum to the contract. The instructions for creating a standard BIM Project Execution Plan template are included in section 4.5: BIM Project Execution Planning Template for Typical Projects.

CASE STUDY EXAMPLE: US Army Corps of Engineers

For projects implementing BIM for the United States Army Corps of Engineers, the project team is required to use the USACE standard BIM Project Execution Planning Template. If the plan developed is unacceptable, it must be re-developed and approved prior to any payment[68]

4.4.3 BIM Champion

The BIM Champion for each organization on the project team play a critical role in communication and information sharing, and can easily influence the success of the project in either a positive or a negative way. It is beneficial to require each project team to designate an individual to operate as the BIM Champion for the project. They will serve as the primary BIM contact and will be the responsible party for each of the project team's BIM issues, as well as the BIM Project Execution Plan. Some potential responsibilities may include:

1. Contribution to the development and compliance of the BIM Project Execution Plan.
2. Management of the quality of BIM model(s) and facility information.
3. Timely sharing of model and data as defined in the BIM Project Execution Plan.
4. Participation in all applicable coordination meetings as defined in the BIM Plan.

4.4.4 Collaboration

Many view BIM as more of a process change than a technology. Much of process change is created through collaboration. By collaborating and sharing information by working together, the project team is able to reduce duplication of work, improve the quality of information, and ensure an efficient project. To achieve these benefits, the entire project team, including the owner, should work in a collaborative manner. For this to occur, everyone must openly share project information in a reliable and up-to-date fashion.

To encourage the necessary collaboration in traditionally delivered projects, it is important to list collaboration requirements explicitly in the contract documentation. This may include:

1. Collaboration between Parties: All project participants should be willing to collaborate with each other as if they were one entity. Agreeing to the collaboration processes and communication procedures detailed in the BIM Project Execution Plan is necessary for all team members. The preliminary BIM Project Execution Plan documenting responsibilities, processes, collaboration, and deliverables should be completed during the contract agreement stage of the project and be included in the final contract for all project participants.
2. Information Sharing: The project team should be willing to share information throughout the duration of the project. This means all parties should have access to the BIM models, reports, facility data, and any other necessary information in real time. This often requires setting up a file exchange website or other collaboration software designed specifically for file sharing.
3. Errors: Any project participant discovering an error must notify the creating party to fix the error.

[68] USACE/Industry BIM Advisory Committee, "Attachment F."

CASE STUDY EXAMPLE: ConsensusDOCS

The ConsensusDOCS contract addresses this problem by requiring "If any project participant becomes aware of a discrepancy between a model and either another model or another contract document, such project participant shall promptly notify the other party or parties to that project participant's governing contract and the information manager.'[69]

4.4.4.1 Co-Location

Perhaps the most optimal method of ensuring collaboration between the project team is by requiring co-location when possible. This is a method of placing the entire project team together in one location to develop the project. Although successful collaboration is possible by communicating remotely, most feel that locating the team together produces a more successful project.

4.4.5 Minimum Deliverables

Throughout the duration of the project, significant savings can be achieved by collecting the data to be used during the operations and renovations of the facility. Traditionally, owners require As-Built drawings, submittals, commissioning reports, and O&M manuals as deliverables. BIM provides the capability for the owner to receive both the model and detailed facility data in an organized, electronic fashion if specified.

4.4.5.1 Minimum As-Built/Record Model Deliverable

The As-Built/Record model deliverable should represent As-Built conditions of the constructed facility. Requiring a model as a deliverable is not adequate. The owner must specify the level of development desired and the format in which it is desired.

Record Model

The owner has many options for specifying the record model deliverable. One option is to require a record model containing design intent information with As-Built conditions. Often considered the most beneficial for facility management, it contains design level detail and lacks fabrication information. This model can be delivered as a federated (model consisting of many discipline specific models combined into one model) static read-only file type such as Autodesk Navisworks or Bentley Navigator. The model can also be provided in a modifiable format such as Autodesk Revit or Bentley Microstation where it can be updated with renovation data. Oftentimes there is additional cost associated with specifying the record model in a modifiable format as this file type is not commonly updated during construction, but it may be the most cost effective solution if the organization plans to use the model for renovation work and facility management.

As-Built Model

Another option is to receive an As-Built model containing construction and fabrication information. This model typically contains much more detail and is created using many discipline specific software

[69] ConsensusDOCS, "ConsensusdDOCS301 BIM Addendum."

packages federated together. This option can also be delivered as a federated read-only version or as many discrete native files.

Industry Foundation Class (IFC)

Whether the owner desires to receive a record model or an as-built model, or both (recommended), it beneficial to ensure that the models are in an IFC (Industry Foundation Class) compatible format. IFC is the standard file type, which allows interoperability between many software platforms and is part of the National BIM Standard.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

Penn State OPP requires a combination of the options mentioned above. They require:

- An As-Built construction model which they use for the as-built documentation of the facility.
- A Record Model in a Revit format which allows them to update the model and use it for renovation work throughout the lifecycle of the facility.[70]

4.4.5.2 Minimum Facility Data Deliverable

Many owners find great value in obtaining the facility information after construction. Most of the data needed for facility management (equipment submittals, O&M manuals, specifications, etc.) is already required in standard contracts to be delivered to the owner, but often it is delivered in a paper format or in electronic PDFs. With new BIM technologies, the owner can now specify exactly the information they require for every piece of equipment in their facility management system, and receive it in a modifiable electronic format. This enables the owner the ability to decrease the time and cost of populating the facility management system.

4.4.5.2.1 Data Attached to a Model

One option an owner has is to request the facility data to be embedded in the As-Built or Record model. The federated model can have facility data attached to elements within the model for use in facility management. This option has benefits because the facility managers can visually see the equipment for which they are receiving information, but it requires model navigation skills and can quickly become outdated for high turnover buildings. The information embedded in the model is also difficult to extract into a facility management system, reducing the effectiveness of the information.

4.4.5.2.2 COBie

An industry standard format for delivering facility data is the Construction Operations Building Information Exchange (COBie). This is a file structure that enables the creators of the data during design, construction, and commissioning to populate a spreadsheet with the desired information such as equipment name, type, location, etc. From that spreadsheet, many facility management systems can import and populate the facility data. This information delivery method is part of the National BIM Standard being developed and is a required deliverable for many owners. Figure 4-3 shows a sample of a spreadsheet populated with facility information.

[70] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

CASE STUDY EXAMPLE: Department of Veteran Affairs

The Department of Veterans Affairs has adopted COBie as the methodology to transfer building information electronically to facilities management.[71]

	Name	TypeName	Space	Description
2	AC Unit Type 1 AC-1	AC Unit Type 1	1B21	AC Unit
3	AC Unit Type 1 AC-2	AC Unit Type 1	1C13	AC Unit
4	AC Unit Type 1 AC-3	AC Unit Type 1	2B12	AC Unit
5	AC Unit Type 1 AC-4	AC Unit Type 1	2C15	AC Unit
6	AC Unit Type 2 AC-5	AC Unit Type 2	2D04	AC Unit
7	ACC-1	Air Cooled Chiller	1F01	M_Screw Chiller - Air Cooled - 281-1231 kW:633-703 kW:633-703 kW:1066741
8	ACCU-1	Air Cooled Condensing Unit- Small	Site	Air Cooled Condensing Unit
9	ACCU-2	Air Cooled Condensing Unit- Small	Site	Air Cooled Condensing Unit
10	ACCU-3	Air Cooled Condensing Unit- Small	Site	Air Cooled Condensing Unit
11	ACCU-4	Air Cooled Condensing Unit- Small	2R02	Air Cooled Condensing Unit
12	ACCU-5	Air Cooled Condensing Unit- Large	2R02	Air Cooled Condensing Unit
13	AHU-1	AHU	2D05	M_Air Handling Unit - Split System - Horizontal:63300000 J:63300000 J:570459
14	AHU-2	AHU	2D05	M_Air Handling Unit - Split System - Horizontal:63300000 J:63300000 J:570439
15	Air Separator AS-1	Air Separator	1E15	Air Separator
16	Air Separator AS-2	Air Separator	2D05	Air Separator
17	Backflow Preventer- 01	Backflow Preventer	1D20	M_Backflow Preventer - 15-50 mm:20 mm:20 mm:1054811
18	Ball Valve 100 mm- 01	Ball Valve 100 mm	1E15	M_Ball Valve - 50-150 mm:100 mm:100 mm:1060496

Figure 4-3: Typical COBie Form Documenting Equipment Information

4.4.5.2.3 Owner Specific Data Requirements

Owners who already have defined requirements and naming standards for their maintenance and operations, there is another option. They can adopt the COBie deliverable and naming standards, or they can specify their own deliverable standard, which incorporates exactly the information they need. This alternative gives the owner more control over their information they receive, but requires significant effort to set up and manage.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

Penn State Office of Physical Plant chose to specify their own facility information deliverable standard because they feel it gives them more flexibility than COBie. To develop this standard, they worked with their facility management group to decide what information needs to be tracked by following a similar process as described in the Organizational BIM Execution Planning for Owners section. From that information, they are developing a database in which a project team will populate the facility information desired.[72]

4.4.6 Ownership of Model/Data Reuse

To enable the information and model created during construction to be used for renovations and throughout operations, the owner must obtain permission from the designer and/or the contractor who created the model. Typically, the creator of the information retains the ownership of the data, and limits its re-use and reliability. This is done to protect intellectual property and limit liability. In order to use this data for more than the initial construction, the owner can specify either that they own the information or have rights to use it throughout the lifecycle of the facility. The right to reuse the data can be achieved two ways:

[71] Dept. of Veterans Affairs, *VA BIM GUIDE v1.0*.
[72] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

1. The owner can claim ownership of all information created during the design and construction of the facility including models, studies, and calculations for the use of renovation/facility management throughout the life of the facility.
2. The owner can claim the right to re-use the information created during the design and construction of the facility for renovation/facility maintenance while allowing the creator to retain ownership of the data.

In many situations, both options add risk to the creator of the information and, therefore, expense to the owner. In the event the data is incorrect, the creator may be liable for the information provided. The owner can limit the use of the data to reduce the creator's risk by:

1. Indemnifying the creators of all errors. This is traditionally how models are delivered to the owner in today's environment. Although this removes the risk for creator, the quality of the information often suffers as there is no incentive to modify/update the information throughout construction. Because the quality of the information suffers, it is not recommended that an owner completely indemnify the creators of the information.
2. Limiting the liability of the information creator for the accuracy of the data only when used for the purpose in which it was created. In this case, the uses should be explicitly stated.
3. Limiting the use of the data for the renovation and operation of the facility in which it was created.
4. Allowing the creator of the information to maintain the right to the intellectual property inherent within the model/data including families, blocks, and styles. This means the information will not be used or shared for any property other than the one for which it was created.

4.4.7 IM Requirements for 2D Documents

With the emphasis for BIM primarily focusing on 3D models and electronic data, it is easy to forget that the contract documents and many details are still in a traditional 2D paper form. In the future 2D documents may not be necessary, but today they are still the contract documents. This means the owner cannot remove any of the Computer Aided Drafting (CAD) or drawing standards they currently employ in their contracts, but must supplement them with additional requirements for BIM. Ensuring the collaboration between the 2D documents and the 3D model is of upmost importance. One way to ensure the consistency between the two is to require that all drawings be produced from the model when possible. This ensures that any change during the duration of the project is documented in both sources.

CASE STUDY EXAMPLE: US Army Corps of Engineers

To ensure the collaboration between 2D documents and the model, the US Army Corps of Engineers requires that all drawings (plans, elevations, sections, schedules, details, etc.) be derived and maintained from the model and facility data.[73]

4.4.8 Security

Before the rise of electronic collaboration, all documents were in paper form, thus it was more difficult for facility information to be acquired by unauthorized personnel. Today with information being

[73] USACE/Industry BIM Advisory Committee, "Attachment F."

transferred electronically, it is much easier to copy, modify, and share information. For many secure facilities, this poses a great risk to the safety and security of its occupants after the completion of construction. To protect against this, the building data must be protected at all stages of its lifecycle from conception to demolition. Data security measures should be taken into consideration and protocols must be established to satisfy the organization's security requirements for all participants accessing the information. These security measures may include:

1. User specific logins to FTP/file sharing websites.
2. Restrictions to the storage of facility information by third parties during and after project completion.
3. Restrictions to sharing of facility information to personnel outside of project team.

4.5 BIM Project Execution Plan Template for Typical Projects

Because the contract requirements rely on a BIM Project Execution Plan to provide project specific information, it is beneficial to develop a standard BIM Project Execution Plan template to be used on future projects. This template not only helps inform potential bidders of the typical expectations of the owner, but it significantly reduces the time and effort required by the owner's BIM Champion for each project.

Once the project specific BIM plan is established by the project team, it should be included into the contract documents so that communication procedures, responsibilities, collaboration processes, model level of development, and deliverables are clear.

This document is not intended to walk the reader through the details of developing a BIM Project Execution Plan, The *BIM Project Execution Planning Guide* provides a much more detailed explanation for the creation of a project specific plan, as well as provides the base template. The goal of this section is to use the *BIM Project Execution Planning Guide Template* and generalize it so that it can be applied on the majority of projects created by the organization.

4.5.1 BIM Standard Goals and Objectives

The first step in developing a standard BIM Project Execution Plan Template is to determine the standard goals and objectives of the organization for which the template is being developed. Most organizations have areas in which they choose to focus which align with their strategic plan. Whether the emphasis is on energy efficiency, cost, speed, or quality, BIM can be used to supplement those goals.

Table 4-3: Example BIM Goals/Objectives and Potential BIM Uses

PRIORITY (Required, Recommended)	GOAL DESCRIPTION	POTENTIAL BIM USES
Required	Improve Construction Quality	Design Review, Design 3D Coordination, Digital Fabrication
Required	Reduce RFIs and Change Orders	Design Review, Design Coordination, Construction 3D Coordination
Required	Reduce Energy Waste	Design Energy Analysis, Programming Energy Analysis
Required	Provide Facility Managers Improved Facility Data after Building Turnover	Record Model, Existing Conditions Modeling

After the standard project goals and BIM objectives are established, they can be added to a table in the BIM Project Execution Plan template as shown in Table 4-3: Example BIM Goals/Objectives and Potential BIM Uses. It is important to note, that these goals may not apply to every project, and once the specifics for a new project are determined, there may be goals that need to be added or removed as decided in the project BIM kickoff meeting.

4.5.1.1 Standard BIM Uses

The project goals and BIM objectives list provides a good starting point for determining the standard project BIM Uses for an organization. An owner should only focus on requiring the BIM Uses, which provide them with a benefit, and not force the project team to change their internal processes if there is no reason. In many situations, architects and contractors will provide additional BIM Uses because it is the most cost effective solution for their internal processes. It is often useful to discuss the potential benefit/costs of each Use with industry partners in design, construction, and operations to determine the implications of each requirement. BIM has been shown to improve projects through many Uses, but it is not the best solution to every problem, and if implemented incorrectly, BIM may increase project cost.

For a list of BIM Uses and their general functions, refer to the BIM Uses descriptions at http://bim.psu.edu.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

OPP provides the following required BIM Uses shown in Table 4-4: BIM Uses List in their generic template. At the beginning of every project, the BIM team meets during the BIM kickoff meeting to finalize on the BIM Uses and potentially add/delete uses.[74]

Table 4-4: BIM Uses List

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING		DESIGN AUTHORING		SITE UTILIZATION PLANNING		DATA COMMISSIONING
	SITE ANALYSIS		DESIGN REVIEWS		CONSTRUCTION SYSTEM DESIGN		PERFORMANCE MONITORING
			3D COORDINATION		3D COORDINATION		SYSTEMS CONTROL
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE TRACKING
			LIGHTING ANALYSIS		3D CONTROL AND PLANNING		ASSET MANAGEMENT
			ENERGY ANALYSIS		RECORD MODELING		MAINTENANCE MANAGEMENT
			MECHANICAL ANALYSIS				CONDITION DOCUMENTATION
			OTHER ENG. ANALYSIS				SCENARIO FORECASTING
			SUSTAINABILITY (LEED) EVALUATION				
			CODE VALIDATION				
	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
	EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING

[74] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

In addition to clearly listing the required BIM Uses, providing a detailed definition of what each Use means to the organization is extremely important. Each BIM Use has many different definitions and levels of implementation depending on the project and parties involved. Providing a project phase specific definition of each required BIM use enables the potential project team the ability to understand their requirements and eliminate any potential misunderstandings.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

OPP defines many BIM Uses slightly differently from other owners. This is because their needs are unique to their organization, and it was found that each Use could be provided much more effectively if the project team understood exactly what the owner wanted from each use.

For example, BIM energy analysis is performed during the design development stage using a high detail model and complex energy software. OPP requires that a traditional energy analysis be performed during design development, but an additional mass model energy analysis be performed during the planning stage. Although this is low in detail and accuracy, it has been shown to help engineers with making quick decisions such as façade, building orientation, and window placement at a stage in the project where changes have a relatively low cost.

In situations such as the energy modeling example, the BIM Use expectations must be detailed in the BIM Project Execution Plan or the project team will not understand the owner's expectations.[75]

4.5.2 Standard BIM Process

The organization template BIM Project Execution Plan also includes a standard BIM process map that demonstrates the typical process the organization encounters on a typical project. This customized map, similar to that shown Figure 4-4, can then provide a starting point for the team at the BIM kickoff meeting. The map should document relationships and identify specific correspondents such as review and approval meetings between the owner and the project team.

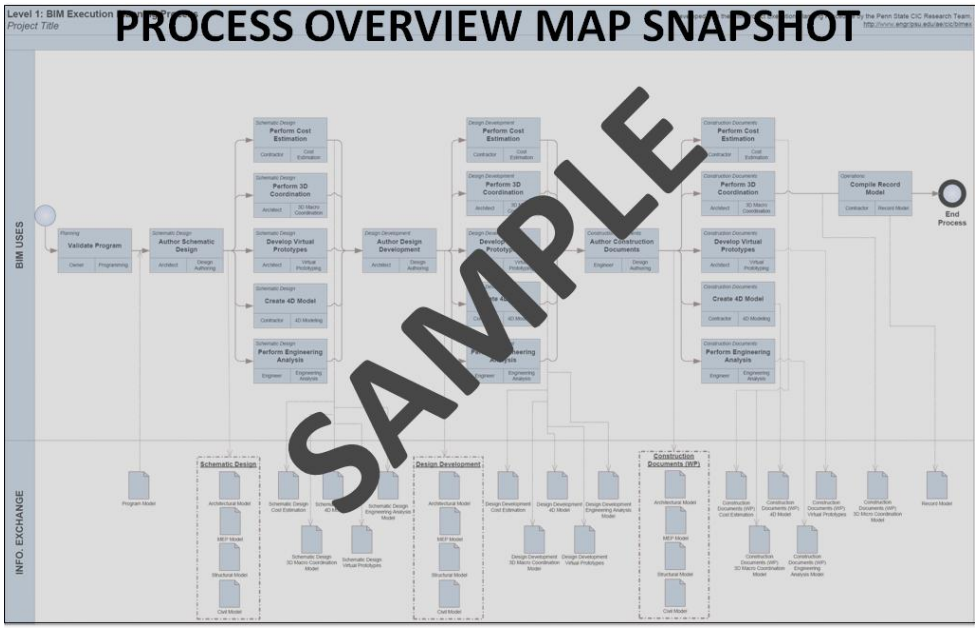


Figure 4-4: Typical BIM Process Map

[75] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

4.5.3 BIM Information Exchanges

As an owner using BIM information for facility management and renovation work, the information needs are very different from that of the contractor and designer. Because of this, it is important to document both the model level of development and facility data property needs at the beginning of the project. The information exchange requirements will consist of two components: the model element level of development and the facility data.

4.5.3.1 Model Detail

To begin, the model information requirements developed through the working group interviews, described in section 3.4.3, should be documented. From this, the Level of Development for the record model can be established and documented in the Information Exchange worksheet pictured in Figure 4-5: Example Information Exchange Worksheet.

It is important that an owner go through each building element individually and determine what level of development is necessary. In most situations, the level of development required for operations is significantly less than that needed for construction, requiring either detail to be removed from the costruction model or the design model be updated. This creates additional effort for the project team, but results in a simplified model that facility managers can utilize more efficiently.

		Design Model		Design		Construction		Operations		Integration with Facilities Management		
		Model Element	Data Only	Construction Documents		Construction Adminstration		Record Model/ As-built Model		Model Element	Data Only	Notes
		Yes/No	Yes/No	LOD	MEA	LOD	MEA	LOD	MEA	Yes/No	Yes/No	
D1010	**Elevators & Lifts**											
	Passenger Elevators							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Freight Elevators							540		Yes	No	See Asset Atttributes list for Additional Requirements
	People Lifts							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Wheelchair Lifts							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Means & Methods (Erection/Sequencing/ Shop Standards)							-		No	Yes	See Asset Atttributes list for Additional Requirements
D1020	**Escalators & Moving Walks**											
	Escalators							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Moving Walks							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Means & Methods (Erection/Sequencing/ Shop Standards)							-		No	Yes	See Asset Atttributes list for Additional Requirements
D1030	**Other Conveying Systems**											
	Dumbwaiters							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Pneumatic Tube Systems							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Hoists and Cranes							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Conveyors							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Chutes							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Turntables							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Baggage Handling and Loading Systems							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Transportation Systems							540		Yes	No	See Asset Atttributes list for Additional Requirements
	Means & Methods (Erection/Sequencing/ Shop Standards)							-		No	Yes	See Asset Atttributes list for Additional Requirements
D2010	**Plumbing Fixtures**											
	Water Closets							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Urinals							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Lavatories							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Sinks							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Bathtubs							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Wash Fountains							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Showers							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Drinking Fountains and Coolers							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Bidets and Other Plumbing Fixtures							530		Yes	No	See Asset Atttributes list for Additional Requirements
	Means & Methods (Erection/Sequencing/ Shop Standards)							-		No	Yes	See Asset Atttributes list for Additional Requirements

Figure 4-5: Example Information Exchange Worksheet

There are several methods of defining the level of development required within a model. A general approach to the problem is to describe the model development one of three ways as shown in Figure 4-6. This method may be a good option for beginners who do not wish to subscribe to any standards such as the AIA Level of Development, but it lacks the detail of other standards and may create unnecessary ambiguity.

Information	
A	Accurate Size & Location, Include Materials and Object Parameters
B	General Size & Location, Include Parameter Data
C	Schematic Size & Location

Figure 4-6: Example Level of Development Description

AIA-E202 provides a good guide for detailing level of development within a model for design and construction, but lacks the detail for use in operations. If the owner wishes to define the level of development necessary for an operations model, it is necessary to expand upon this standard to suit their operational needs.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

The Penn State OPP has expanded upon the AIA level of development and adapted it to provide additional information for facilities management. This detailed level of development scale is an option an owner can incorporate into their information exchange worksheet in an effort to provide the project team additional information needs.

The updated definitions are as follows:

LOD 100: Schematic Design; overall building massing; whole building analysis (volume, orientation, square footage costs).

LOD 200: Design Development; generalized systems/assemblies (approximate quantities, size, shape, location, orientation); selected system performance analysis.

LOD 300: Construction Documentation; generation of traditional CD's and shop drawings; analysis and simulation of detailed elements/systems; includes attributes and parameters defined by PSU.

LOD 400: Construction Administration/Shop Drawings; includes specific assemblies which are accurate in terms of quantity, size, shape, location, and orientation; virtual representations of the proposed elements, suitable for construction, fabrication, and assembly.

LOD 510: Model elements represent the project as constructed in As-Built conditions. LOD 510 models will contain LOD 100 facility and geometry data and will be configured to contain the operations & maintenance manuals, warranty information, submittal information, and/or any other documents as applicable.

LOD 520: Model elements represent the project as constructed in As-Built conditions. LOD 520 models will contain LOD 200facility and geometry data and will be configured to contain the operations & maintenance manuals, warranty information, submittal information, and/or any other documents.

LOD 530: Model elements represent the project as constructed in As-Built conditions. LOD 530 models will contain LOD 300 facility and geometry data and will be configured to contain the operations & maintenance manuals, warranty information, submittal information, and/or any other documents as applicable.

LOD 540: Model elements represent the project as constructed in As-Built conditions. LOD 540 models will contain LOD 400 facility and geometry data and will be configured to contain the operations & maintenance manuals, warranty information, submittal information, and/or any other documents as applicable.

LOD 550: Owner reserved, LOD 550 model elements will not be generated during planning, design, or construction.[76]

[76] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

4.5.3.2 *BIM and Facility Data Requirements*

Although the model is very useful for facility management and renovations, perhaps more important to operating the facility is the facility data. Traditionally items such as submittals, operations & maintenance manuals, warranty information etc. are delivered after project completion in the form of paper binders or PDFs. Transitioning this data to a useful format is further convoluted because the owner often does not receive these documents until over a year after substantial completion. With these documents in "paper" format, facility managers must search through the pages of information they need and then manually populate their facility management system. The necessary properties and attributes (facility data) of each building element should be documented in the BIM Project Execution Plan as defined in the BIM Contract Requirements to allow for electronic data transfers.

CASE STUDY EXAMPLE: Penn State Office of Physical Plant

Penn State OPP lists every asset and the properties for which it wants discrete information delivered at the end of the project. Although Penn State utilizes a customized list as shown in Table 4-5: Sample of PSU OPP Asset Attribute List organized according to PSU UNIFORMAT II Standard, COBie is also capable of housing this information; however, an owner still needs to specify the necessary elements and attributes of those elements.[77]

Table 4-5: Sample of PSU OPP Asset Attribute List organized according to PSU UNIFORMAT II Standard

Asset	Parameter	UOM
D10 Conveying		
Elevator	Elevator Number	
	Number of Elevator Landings	#
	Passenger Capacity	LB
	Elevator Type	
	Elevator Maximum Load	LB
	Elevator Speed	FPM
	Model	
	Model #	
	Manufacturer	
	Serial Number	

4.5.4 Collaboration/Meeting Procedures

All the necessary meetings between the project team and the owner should be set in advance as shown in Table 4-6: Example BIM Project Meeting Schedule. This helps the project team understand their time commitments to the owner from day one. These meetings can consist of the BIM kickoff meeting, multiple review meetings, or any other meeting necessary to complete the BIM Uses/Requirements.

[77] PSU Applied Facilities Research Group, "PSU OPP BIM Addendum."

Table 4-6: Example BIM Project Meeting Schedule

MEETING TYPE	PROJECT STAGE	FREQUENCY	PARTICIPANTS	LOCATION
BIM REQUIREMENTS KICK-OFF	Programming	Once	Owner, Architect	TBD
BIM EXECUTION PLAN DEMONSTRATION	Programming	Once	Owner, BIM Participants	TBD
ENERGY MODEL REVIEW	Programming	As Needed	Owner, Architect	TBD
DESIGN REVIEW	Programming, Design	Monthly	Owner, Architect	
CONSTRUCTION OVER-THE-SHOULDER PROGRESS REVIEWS				
ANY OTHER BIM MEETINGS THAT OCCURS WITH MULTIPLE PARTIES				

4.5.5 Project Deliverables

Clearly defining the BIM deliverable details is the final step to the development of a standard BIM Project Execution Plan template. Project BIM deliverables can be used essentially as a checklist of items, which must be received for the payment to be processed during each stage of the project. Deliverables such as programming validation reports, energy models, to closeout data can all be specified in the desired format at the desired time as Table 4-7: Example Project BIM Deliverables illustrates.

Table 4-7: Example Project BIM Deliverables

BIM SUBMITTAL ITEM	STAGE	APPROXIMATE DUE DATE	FORMAT	NOTES
Programming Report	Programming	TBD	PDF	
Energy Model	Design Development	TBD	GBXML	
Design Model	Design Development	TBD		
Record Model	Close Out	TBD	Revit	See Record Model Information Exchange to ensure that the proper information is contained in this model
As-Built Model	Close Out	TBD	Navisworks, Native	See Record Model Information Exchange to ensure that the proper information is contained in this model

4.6 Summary and Recommendations for BIM Project Procurement Planning

By developing a comprehensive working set of BIM Contract Language including the RFP, RFQ, contract requirements, and Typical BIM Project Execution Plan Template, an owner can begin with the adoption of BIM within their organization.

The Request for Qualifications (RFQ) is the first step an owner has at evaluating a team's BIM abilities. Experience, skill, and willingness to collaborate can all quickly be determined by the RFQ, saving the owner time and money down the road.

The Request for Proposal (RFP) will enable the owner to successfully acquire BIM Uses early in the project. With an adequate Typical Project BIM Execution Plan template and Contract Requirements, along with the RFP, the bidder can accurately price the necessary BIM Uses and provide the owner with a BIM plan customized to their needs.

The contract requirements provide the project team with the general BIM expectations the owner expects. It emphasizes the necessity of the BIM Project Execution Plan and collaboration within the project.

The Typical BIM Project Execution Plan Template provides the project team with detail on the owner expectations and a starting point for developing the working BIM Execution Plan for the project.

With all these procurement documents working together, the owner is able to successfully procure BIM Uses on a project basis, and utilize the model and facility data throughout the lifecycle of the building for facility management.

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5 Concluding Remarks

The BIM Planning Guide for Facility Owners provides methods for facility owners to plan for the integration of BIM within their organization. BIM planning has many aspects including BIM Project Execution Planning (included in a separate BIM Project Execution Planning Guide), BIM Organization Execution Planning, BIM Strategic Planning, and BIM Project Procurement Planning. Woven throughout this Guide are standard planning elements including strategy, uses, process, information, personnel and infrastructure. When planning for each aspect, it is important to account for each of the planning elements.

Strategic Planning for BIM addresses the procedure used to assess existing organizational conditions, align BIM goals and vision, and develop a transition path for the implementation of BIM for operations. Owner Organizational Execution Planning for BIM addresses each of the BIM planning elements for detailed implementation within the operations of the organization. BIM procurement planning identifies key contractual issues an owner must consider when creating contract requirements and a standard BIM Project Execution Plan template. The BIM Project Execution Planning Guide provides a method for project teams and organizations to plan the execution of BIM using formal, standard processes. Each of these aspects is a vital part of a comprehensive BIM strategy and together can provide the necessary structure for integration of BIM within an organization and project.

The Guide was created through a rigorous methodology that includes content analysis, industry interviews, observational case study, and workshops. The structure of the Guide, along with the content, has undergone expert review prior to public dissemination. The BIM planning aspects and planning elements will be validated using various methods including industry expert review, quasi-experiments, and case studies. Industry review will be obtained through interviews, unsolicited feedback and surveys. The case studies will be conducted with organizations of varying size and at various BIM implementation maturity levels. For validation, the case studies will implement the various aspects of the BIM Planning Guide for Facility Owners by applying them to real world situations. After the Guide has been validated, it will be updated based on the lessons learned and feedback received.

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Appendix

A. Organizational BIM Assessment Profile
B. Strategic Plan Template
C. Owner BIM Organizational Execution Plan Template
D. Business Case Template
E. Project Procurement Documents
F. Planning Elements
G. BIM Uses
H. Citations
I. Abbreviations
J. Glossary
K. Index

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Appendix A Organizational BIM Assessment Profile

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
Strategy	**The Mission, Vision, Goals, and Objectives, along with management support, BIM Champions, and BIM Planning Committee.**	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**0**	**0**	**25**
Organizational Mission and Goals	A **Mission** is the fundamental purpose for existence of an organization. **Goals** are specific aims, which the organization wishes to accomplish.	No Organizational Mission or Goals	Basic Organizational Mission Established	Established Basic Organizational Goals	Organization Mission Address Purpose, Services, and Values	Goals are Specific, Measurable, Attainable, Relevant, and Timely	Mission and Goals are Regularly Revisited, Maintained and Updated (as necessary)	**0**	**0**	**5**
BIM Vision and Objectives	A **Vision** is a picture of what an organization is striving to become. **Objectives** are specific tasks or steps that when accomplished move the organization toward their goals.	No BIM Vision or Objectives Defined	Basic BIM Vision is Establish	Established Basic BIM Objectives	BIM Vision Address Mission, Strategy, and Culture	BIM Objectives are Specific, Measurable, Attainable, Relevant, and Timely	Vision and Objectives are Regularly Revisited, Maintained and Updated (as necessary)	**0**	**0**	**5**
Management Support	To what level does management support the BIM Planning Process.	No Management Support	Limited support for Feasibility Study	Full support for BIM Implementation with Some Resource Commitment	Full Support for BIM Implementation with Appropriate Resource Commitment	Limited Support for Continuing Efforts with a Limited Budget	Full Support of Continuing Efforts	**0**	**0**	**5**
BIM Champion	A BIM Champion is a person who is technically skilled and motivated to guide an organization to improve their processes by pushing adoption, managing resistance to change and ensuring implementation of BIM.	No BIM Champion	BIM Champion Identified but Limited Time Committed to BIM Initiative	BIM Champion with Adequate Time Commitment	Multiple BIM Champions with Each Working Group	Executive Level BIM Support Champion (with limit time commitment)	Executive-Level BIM Champion Working Closely with Working Group Champion	**0**	**0**	**5**
BIM Planning Committee	The BIM Planning Committee is responsible for developing the BIM strategy of the organization.	No BIM Planning Committee Established	Small Ad-hoc Committee with Only Those Interested in BIM	BIM Committee is Formalized but not Inclusive of all Operating Units	Multi-Disciplinary BIM Planning Committee Established with Members from all Operative Units	Planning Committee Includes Members for all Level of the Organization, Including Executives	BIM Planning Decisions are Integrated with Organizational Strategic Planning	**0**	**0**	**5**

A

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
BIM Uses	**The specific methods of implementing BIM**	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**0**	**0**	**10**
Project Uses	The specific methods of implementing BIM on projects	No BIM Uses for Projects Identified	No BIM Uses for Projects Identified	Minimal Owner Requirements for BIM	Extensive Use of BIM with Limited Sharing between Parties	Extensive Use of BIM with Sharing between Parties within Project Phase	Open Sharing of BIM Data across All Parties and Project Phases	**0**	**0**	**5**
Operational Uses	The specific methods of implementing BIM within the organization	No BIM Uses for Operations Identified	Record (As-Built) BIM Model Received by Operations	Record BIM Data Imported or Referenced for Operational Uses	BIM Data Manually Maintained for Operational Uses	BIM Data is Directly Integrated with Operational Systems	BIM Data Maintained with Operational Systems in Real-Time	**0**	**0**	**5**
Process	**The means by which the BIM Uses are accomplished.**	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**0**	**0**	**10**
Project Processes	The documentation of External Project BIM Processes	No External Project BIM Processes Documented	High-Level BIM Process Documented for Each Party	Integrated High Level BIM Process Documented	Detailed BIM Process Documented for Primary BIM Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	**0**	**0**	**5**
Organizational Processes	The documentation of Internal Organizational BIM Processes	No Internal Organizational BIM Processes Documented	High-Level BIM Process Documented for Each Operating Unit	Integrated High Level Organizational Process Documented	Detailed BIM Process Document for Primary Organizational Uses	Detailed BIM Process Documented for all BIM Uses	Detailed BIM Process Documented and Regularly Maintained and Updated	**0**	**0**	**5**

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
Information	**Information Needs refer to Model Level of Development and Facility Data requirements**	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**0**	**0**	**15**
Model Element Breakdown (MEB)	Model Element Breakdown Structure identifiers are assigned to each physical or functional element in the breakdown of the facility model.	No Consistent Organizational Model Element Breakdown	Organizational Model Element Breakdown Defined but Not Uniform within Entire Organization	Organizational Model Element Breakdown is Uniform within the Organization	Organizational Model Element Breakdown Aligned with Industry Standards	Organizational Model Element Breakdown Updated Along with Industry Standards	Organizational Modifications to Industry Standard Model Element Breakdown are Balloted for Inclusion in Industry Standards	**0**	**0**	**5**
Level of Development (LOD)	The Level of Development (LOD) describes the level of completeness to which a model element is developed.	No Consistent Level of Development	LOD Defined but Not Standardized within the Entire Organization	LOD Standardized within the Organization	Organizational LOD Standards Aligned with Industry Standards	Model View Definitions & Information Delivery Manuals are used to define LoD	Organizational modification to MVDs and IDMs are balloted for inclusion in industry standards	**0**	**0**	**5**
Facility Data	Facility Data is non-graphical information that can be attached to objects within the model that defines various characteristics of the object.	No Consistent Facility Data Requirement	Facility Data Defined but Not Internally Standardized	Facility Data Defined and Standardized within the Organization	Organizational Facility Data Attributes Aligned with Industry Standards	Facility Data Attributes Aligned with Open Standards	Facility Data Attributes Updated with Open Standards	**0**	**0**	**5**
Infrastructure	**Technological and physical systems needed for the operation of BIM with the organization.**	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**0**	**0**	**15**
Software	The programs and other operating information used by a computer to implement BIM.	No BIM Software	Software Capable of Accepting BIM Data	Facility Data Defined and Standardized within the Organization	Advanced BIM Software Systems	All Software Systems Available to all Personnel	Program Established for Continuous Updating of BIM Software Systems	**0**	**0**	**5**
Hardware	Physical interconnections and devices required to store and execute (or run) BIM software.	No Hardware Capable of Running BIM Software	Some Hardware Capable of Running Basic BIM Software	Facility Data Defined and Standardized within the Organization	Some Advanced Hardware Systems with the Organization	All Organization Hardware is Capable of Running Advanced BIM Software	Program Established for Continuous Updating of BIM Hardware Systems	**0**	**0**	**5**
Physical Spaces	Functional areas within a facility used to properly implement BIM within the organization.	No Dedicated BIM Space	Single Workstation for Viewing BIM Data	Facility Data Defined and Standardized within the Organization	BIM Room for Collaborating with Large Screen Viewing Capability	Multiple Collaborative Workspaces within Regular Workspace	Program Established for Continuous Updating of BIM Spaces	**0**	**0**	**5**

A

Planning Element	Description	Level of Maturity						Current Level	Target Level	Total Possible
Personnel	**Human resources of an organization**	**0 Non-Existent**	**1 Initial**	**2 Managed**	**3 Defined**	**4 Quantitatively Managed**	**5 Optimizing**	**0**	**0**	**25**
Roles and Responsibilities	Roles are the primary function assumed by a person within the organization and responsibilities are the tasks or obligations that one is required to do as part of that role	No Roles and Responsibilities Documented	BIM is the Responsibility of the BIM Champion	BIM is the Responsibility of the BIM Group	BIM Responsibility Lies with each Operating Unit	BIM Responsibility Lies with Each Person	BIM Responsibilities are Regularly Reviewed to Ensure they are Properly Distributed	**0**	**0**	**5**
Organizational Hierarchy	An arrangement of personnel and group into functional groups within the organization	Organizational Hierarchy does Not Address BIM	BIM Champion Outside of Typical Organizational Hierarchy	Small BIM Implementation Team Outside the Typical Organization Hierarchy	Large mulit-disciplined BIM Group Created	BIM Champion Defined within Each Operating Unit	BIM Implementation Team Supports BIM Use within Operating Units	**0**	**0**	**5**
Education	Education is to formally instruct about a subject.	No Education Program	Ad-hoc Education as Needed	Formal Presentations on what is BIM and the Benefits it has for the Organization	Regularly Conducted Employee Education Sessions	On-Demand Education Program Established for the Organization	Education is Seamlessly Improved through Lessons Learned within the Organization	**0**	**0**	**5**
Training	Train is to teach so as to make fit, qualified, or proficient in a specific task or process	No Training Program	Training Program run by Vendors - only for Necessary Personnel	Internal Training Program for all Personnel that may Interact with BIM	Regularly Conducted and Routine Training Programs	On-Demand Training Program Established for the Organization	Training is Seamlessly Improved through Lessons Learned within the Organization	**0**	**0**	**5**
Change Readiness	The willingness and state preparedness of an organization to integrate BIM.\	No Change Readiness Awareness	Established Need for BIM	Upper Management Buy-in	Operating Unit Buy-in	All Individuals Buy-in	Willingness to Change is Part of the Culture of the Organization	**0**	**0**	**5**
Totals	This is the total for all the categories. Note this does reflect maturity in all sections. While the organization could score high, there could be some key areas not implemented that could hinder the organizations BIM Implementation.							**0**	**0**	**90**

Appendix B Owner Organization Strategic BIM Plan Template

(See attached Strategic Planning Template)

B

Appendix C Organizational Execution Plan Template

(See attached Organization Execution Plan Template)

C

Appendix D Business Case Template

(See attached Business Case Template)

D

Appendix E Procurement Templates

(See attached Procurement Templates)

E

Appendix F BIM Planning Element Descriptions

Throughout all BIM Planning Procedures, serveral core elements, at differing levels of complexity, repeat themselves. The core elements are refered to as BIM Planning Elements.

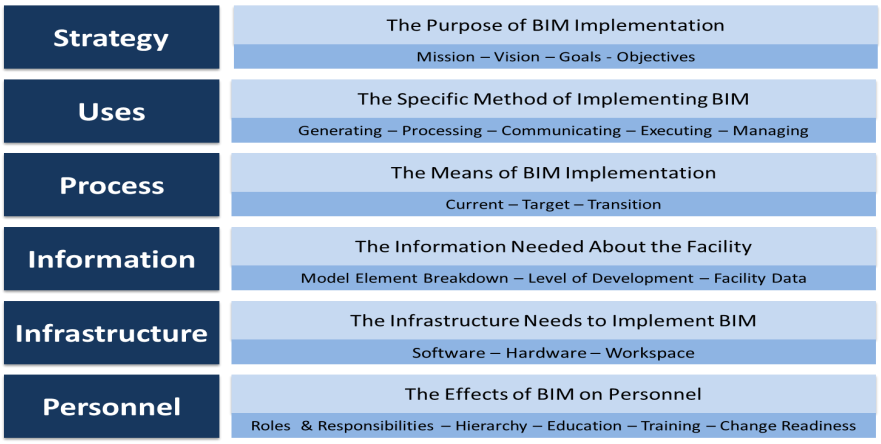

Figure 0-1: The BIM Planning Elements

F1 Strategy

The planning elements related to the overall BIM Strategy including mission, vision, goals, and objective; management and resource support, BIM champion(s) and BIM planning committee

F2 BIM Uses

During each aspect of planning the specific methods in which BIM will be implemented, or BIM Uses, need to be considered. This includes BIM Uses for generating, processing, communicating, executing, and managing information about the facility.

F3 Process

Those planning elements related to organizational and project BIM Processes including documenting the current processes, designing BIM-enabled processes, and developing transition processes.

F4 Information

Those elements related to the facility data information needs of the organization including model element breakdown, level of development, and facility data information needs.

F5 Infrastructure

Those elements related to BIM infrastructure including software, hardware, and spaces.

F6 Personnel

Those elements related to those employees related to BIM including roles and responsibilities, organizational structure, education and training program.

Appendix G BIM Use Descriptions

The following is a list of BIM Uses critical to a facility owner. For a more complete list of BIM Uses, see http://bim.psu.edu.

- **Data Commissioning:** A process in which facility data, such as part numbers, warranty information, from a BIM Model is used to populate an organization's facility management system (FMS) while ensuring the accuracy of the information and significantly reducing the data entry time.
- **Performance Monitoring:** A process in which BIM can be used to assist in monitoring the preformation of the facilities including items such as energy, air quality, and security.
- **Systems Control:** A process in which BIM can be used to assist in controlling elements or systems of the facility such as lighting, electrical, HVAC, and conveying to name a few.
- **Space Tracking:** A process in which BIM is used to monitor the usage of spaces within the facility.
- **Asset Management:** A process in which BIM is used to assist in the management of facility assets to ensure optimal value over its life cycle. These assets, consisting of the physical building, systems, surrounding environment, and equipment, must be maintained, upgraded, and operated at an efficiency which will satisfy both the owner and users at the lowest appropriate cost to support financial decision-making as well as short-term and long-term planning. Asset categories can include personnel, space, equipment, systems, FF&E systems and components, Information Technology and Audio-Video systems components and other data to be determined to be of value by each customer.
- **Maintenance Management:** A process in which BIM is used to assist in actions intended to retain facility elements, or restore facility elements to, a state in which the facility element can perform its intended function.
- **Condition Documentation:** A process in which BIM is used to assist in recording the state of the facility. This can be accomplished with a number of tools including but not limited to laser scanning, photo-geometry, and traditional surveying.
- **Scenario Forecasting:** A process in which BIM is used to predict possible situations within the facility such as crowd flow, evacuation procedures and other disasters.

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Appendix I Abbreviations

2D – Two-Dimensional

3D – Three-Dimensional

AEC – Architecture Engineering Construction

AIA – American Institute of Architects

BIM – Building Information Model(ing)

BPMN – Business Process Mapping Notation

bSa – buildingSMART alliance

Computer Aided Drafting

CAFM – Computer Aided Facility Management

CIC – Computer Integrated Construction Research Program

CIFE – Center for Integrated Facilities Engineering

CM – Construction Management

CMMI – Capability Maturity Model Integrated

CMMIS – Computerized Maintenance Management Information System

CMMS – Computerized Maintenance Management Systems

COBie – Construction Operations Building Information Exchange

CPM – Critical Path Method

DB – Design-Build

DBB – Design-Bid-Build

DoD – Department of Defense

E&TM – Equipment and Technology Management

FF&E – Furniture, Fixtures, and Equipment

FLCM – Facility Life-Cycle Management

FM – Facility Management

FMS – Facility Management System

FTP – File Transportation Protocol

HBC – Healthcare BIM Consortium

HVAC – Heating Ventilation and Air Conditioning

IDEF – Integrated Definition

IFC – Industry Foundation Class

IO&T – Initial Outfitting and Transition

LoD – Level of Development

MHS – DoD Military Health System

NBIMS-US – The United States National Building Information Modeling Standards

NFS – National Facilities Services (Kaiser Permanente)

OPP – Office of Physical Plant

PACE – The Partnership for Achieving Construction Excellence

PDF – Portable Document Format

PFD – Program for Design

PSU – The Pennsylvania State University

PxP – Project Execution Plan

RAM – Random Access Memory

RFP – Request for Proposal

RFQ – Request for Qualifications

SWOT – Strength, Weakness, Opportunity, Threat

USACE – United States Army Corps of Engineers

UML – Unified Modeling Language

VA – Department of Veteran Affairs

Appendix J Glossary

As-Built Model: A model representing the as-built conditions of a facility. Often times delivered as a federated model with the level of development required for constructed.

BIM (Building Information Modeling) (CIC Research Program): A process focused on the development, use, and transfer of a digital information model of a building project to improve the design, construction and operations of a project or portfolio of facilities.

BIM (Building Information Model) (NBIMS): A digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder.

BIM Champion: A person who is technically skilled and motivated to guide an organization to improve their processes by pushing adoption, managing resistance to change, and ensuring implementation of a new technology or process.

BIM Deliverables: Information (in numerous formats) that may be required by contract or agreement to be submitted or passed to another party.

BIM Goals: Objectives used to define the potential value of BIM for a project and for project team members. BIM Goals help to define how and why BIM will be used on a project or in an organization.

BIM Process: A generic name for the practice of performing BIM. This process can be planned or unplanned. The BIM Process may also be referred to as the BIM Execution Process or the BIM Project Execution Process. The BIM Project Execution Planning Process suggests diagramming the BIM process using process maps.

BIM Process Maps: A diagram of how BIM will be applied on a project. The BIM Project Execution Plan proposes two levels of Process Maps: BIM Overview Map and Detailed BIM Use Process Maps.

BIM Project Execution Plan (BIM PxP or BIM Plan): A planning the results from the BIM Project Execution Planning Process. This document lays out how BIM will be implemented on the project as a result of the decision of the group.

BIM Project Execution Planning Procedure: A process for planning the execution of BIM on a project. It consists of four primary steps: 1) identify BIM Goals and BIM Uses, 2) design BIM Project Execution Process, 3) develop Information Exchanges, 4) define supporting infrastructure for BIM Implementation.

BIM Use: A method or strategy of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives.

Construction Operations Building Information Exchange (COBie): A specification that denotes how information may be captured during design and construction and provided to facility operators.

Co-Location: A collaboration technique where the entire project team moves into one location to develop a project.

Detailed BIM Use Process Maps: A comprehensive BIM Process Map that defines the various sequences to perform a specific application of BIM or BIM Uses. These maps also identify the responsible parties for each process, reference information content, and the information exchanges which will be created and shared with other processes.

Fabrication Model: A BIM model with an adequate level of detail and accuracy for use in prefabrication.

Federated Model: A BIM model that is the combination of BIM models (i.e. Architecture, plumbing, electrical, and HVAC). Often used for 3D coordination.

Information Exchange (IE): The information passed from one party to another in the BIM process. The parties involved should agree upon and understand what information will be exchanged. These are often in the form of deliverables from a process that will be required as a resource for future processes.

Level of Development(LoD): The level of completeness to which a model element is developed.

Objective: Specific tasks or steps that when accomplished move the organization toward their goals.

Operating Units: A working group within an larger organization that has a specific mission

Overview Map: A high level BIM Process Map that illustrates the relationship between BIM Uses which will be employed on the project.

J

Project Team: Every participant contracted to work on a project. This may include the owner, designer, contractor, and subcontractor.

Record Model: A facility model illustrating as-built conditions in the Level of Development and file format specified by the owner.

Reference Information: Structured information resources (enterprise and external) that assist or are required to accomplish a BIM Use.

Roadmapping: The process of displaying the integration of strategic changes in a business process.

Vision Statement: A picture of what an organization is striving to become. [78]

[78] Drohan, "Writing a Mission Statement."

Appendix K Index

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