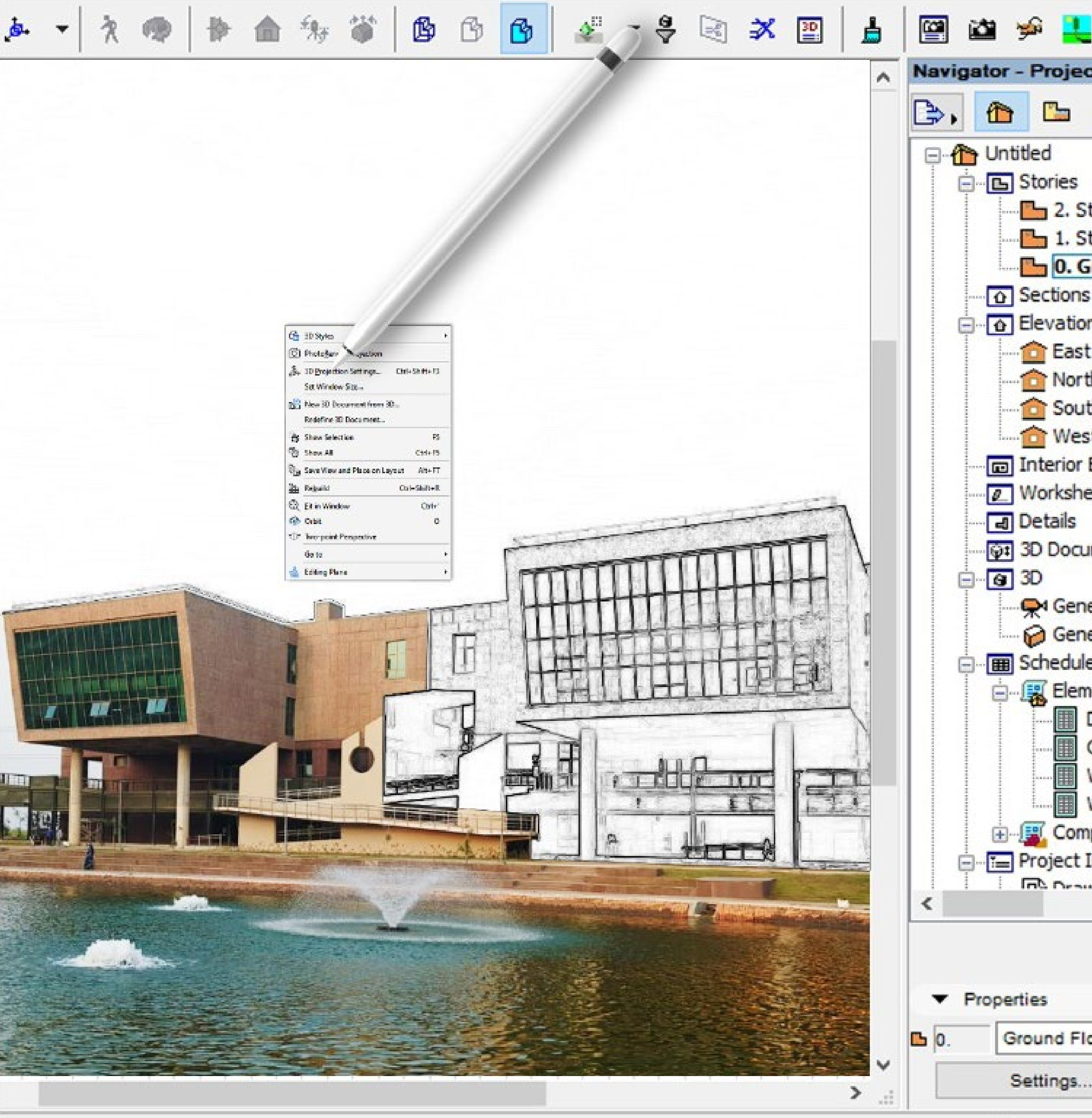
Introducing BIM in CPWD



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MESSAGE

Building Information Modelling (BIM) represents a pivotal shift in the way we conceive, design, construct, and manage buildings. In today's dynamic architectural landscape, where precision, collaboration, and sustainability are paramount, BIM emerges as not just a tool but a transformative strategy.

'Introducing BIM in CPWD' is your gateway to understanding the essence and application of BIM in the context of modern architecture and construction. Whether you're an architect, engineer, builder, or student entering the field, the insights within these pages will empower you to navigate the complexities of BIM with confidence.

CPWD has made significant strides in implementing an Enterprise Resource Planning (ERP). To further enhance the capabilities of the CPWD ERP, it is crucial to focus on capacity building in the adoption of Building Information Modelling (BIM). BIM adoption will enhance project efficiency, collaboration, and overall project outcomes, ensuring that the ERP system is used to its fullest potential.

BIM transcends traditional boundaries, integrating data, technology, and collaboration to redefine how we conceive, visualize, and construct buildings. From conceptualization and design to construction and operation, BIM fosters enhanced communication, improved decision-making, and streamlined workflows across all phases of a project.

As we embark on this journey together, let us embrace the possibilities that BIM presents-a future where creativity meets precision, and where collaboration drives excellence in the built environment.

I would like to extend my heartfelt congratulations to Shri S. P. Chaudhary, SDG (HQ), Shri Ujwal Mitra, ADG (Training & Research), Shri Naimuddin, ADG (Tech), Shri Manu Amitabh DDG (ERP) (Retd) and Shri Devendra Kumar Sachan, Director (Tech & PR), along with their dedicated team and other experts, for successfully bringing out this introductory volume on BIM on such a short notice.

New Delhi
July, 2024

(Rajesh Kumar Kaushal)

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MESSAGE

We are delighted to present **"Introducing BIM in CPWD,"** a comprehensive guide designed to illuminate the transformative potential of Building Information Modelling (BIM) within the Central Public Works Department (CPWD). This book provides an essential roadmap for engineers, architects, planners, and stakeholders involved in the public sector infrastructure projects.

BIM is revolutionizing the way construction projects are planned, designed, executed, and managed. With a focus on integrating BIM practices into CPWD's operations, this book offers insights into the benefits, challenges, and best practices for adopting this cutting-edge technology. The contents are crafted to align with CPWD's vision for improving efficiency, reducing costs, and enhancing the quality of public infrastructure.

Whether you are new to BIM or looking to deepen your understanding, this book serves as a vital resource. Join us on this journey towards modernizing public construction projects and advancing the future of infrastructure development in India.

I extend my sincere appreciation to the committee members: Shri Ujjwal Mitra, ADG (Trg); Shri Kamal Ahmad, ADG(Works); Shri Prem Mohan, CE (CSQ); Shri Devendra Kumar Sachan, Director (Tech&PR); Shri P. Sridhar, SE Hyderabad; Shri Chander Pal, SE, AIIMS Rishikesh; Shri S. P. Gupta, Director (ERP), Shri Sheel Rajneesh, Director (ERP); Shri Vivek Gupta, SE, MNIT Jaipur; Shri C. S. Abineesh, EE-Tirupati; Shri S. S. Rana, Architect; Shri Purnendu Prakash Pathak, Architect and Shri Rahul Narain, Architect for their significant contributions.

We hope this book inspires and equips you to embrace BIM and take part in the ongoing evolution of our nation's-built environment.

New Delhi
July, 2024

(Shatrughna Prasad Chaudhary)

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FOREWORD

In today's dynamic world of architecture, engineering, and construction (AEC), embracing latest technology is not just an option but a necessity. Building Information Modelling (BIM) stands at the forefront of this technological revolution, promising efficiency, accuracy, and collaboration like never before.

CPWD plays a pivotal role in shaping India's infrastructure landscape. Introducing BIM within CPWD marks a significant milestone, signalling a shift towards modern practices that enhance project delivery and facility management.

This book, **"Introducing BIM in CPWD,"** serves as a comprehensive guide to navigate this transformative journey. From the fundamentals of BIM to its practical applications within CPWD projects, this resource materials equips professionals with the knowledge needed to harness BIM's full potential. It not only outlines the technical aspects but also explores the organizational impact, emphasizing how BIM fosters greater integration across disciplines and stakeholders.

As we embark on this transformative endeavour, it is crucial to recognize that successful adoption of BIM is not merely about technology; it is about fostering a culture of collaboration and innovation. By embracing BIM, CPWD not only enhances project outcomes but also sets a benchmark for the industry, driving efficiency and sustainability.

I would like to express my heartfelt gratitude to Shri Rajesh Kumar Kaushal, DG, CPWD and Shri S. P. Chaudhary, SDG(HQ)/PRND for their invaluable guidance throughout this endeavour. My sincere thanks also go to all other members of the Committee for their valuable inputs in preparing this book.

I would like to extend our heartfelt gratitude towards Dr Amarnath CB, President, India BIM Association, Shri Senthilkumar Venkatachalam, Professor, IIT Palakkad, Lt. Col. Onkar C Bhandurge and the teams at Autodesk, Archi CAD, Bentley Systems and Trimble for their invaluable contributions in preparing the book. Their expertise, dedication, and collaborative spirit have been instrumental in bringing out this Book. This book stands as a testament to the power of teamwork and shared knowledge. We are grateful to everyone who has contributed to its creation and look forward to the positive impact on construction industry.

New Delhi
July, 2024

(Devendra Kumar Sachan)

PREFACE

The Digital transformation strategy at Central Public Works Department, Govt. of India (CPWD) emphasizes on developing Building Information Modelling (BIM) and digital twin throughout the project and utilizing it from across all phases of project (including asset management). This approach aims to enhance collaboration, communication and coordination among the project stakeholders and improves overall quality of data sharing and usage.

As CPWD became more familiar with BIM workflows, and as increasing numbers of architects, engineers, and constructors began using BIM approach, CPWD recognized that a standardized approach was required in order to maximize the potential of BIM and digitalisation in design, construction, and facilities management and maintenance.

CPWD aims to increase the efficiency of the construction process by minimizing constructability issues on-site through BIM and associated procedures by a centralized platform for all the information related to the project. This information database is shared among all the stakeholders, from which all the relevant information related to the project can be efficiently extracted and stored, giving rise to better management and enhanced productivity. This Information rich model assists in the construction processes from the design phase to execution and may thereafter be used as an organized digital database for maintenance related to build asset management.

The implementation of BIM facilitates a highly integrated design and construction process that results in a better-quality project apart from minimizing the construction and maintenance cost, construction time and energy consumption during the construction as well as the operation of a project.

This introductory volume on BIM has been developed to successfully implement BIM & digitalization approach in the projects at CPWD as a National Framework/ Roadmap for India and its Infrastructure Growth through transparency, accessibility and sustainability. Within this volume, BIM Uses, the expected benefits and goals deriving from its usage and the BIM process and standards which need to be followed and maintained by all the project stakeholders for modelling and managing the model throughout the project life cycle have been defined.

PURPOSE

The purpose of this Introductory Book on BIM is to provide a comprehensive understanding and clear explanations regarding the fundamental functionalities, usage, and the roles and responsibilities of various stakeholders in creating BIM and to use the same across the project life cycle. This handbook showcases on how BIM plays a vital role in improving construction processes and how projects, individuals, and our organization can derive significant advantages from adopting BIM methodologies. Specifically, the emphasis is on defining the essence of BIM and elucidating the tangible benefits that arise from implementing BIM practices during the construction phase of projects.

ACRONYMS

AEC - Architecture, Engineering and Construction

AIM - Asset Information Model

AIR - Asset Information Requirements

AR - Augmented Reality

BCF - BIM Collaboration Format

BEP/BXP - BIM Execution Plan

BIM - Building Information Modelling

CAD - Computer Aided Design

CDE - Common Data Environment

COBie - Construction-Operations Building Information Exchange

CM - Construction Manager

CMMS - Computerized Maintenance Management System

CPWD - Central Public Works Department

DPoW - Digital Plan of Work

ECMS - Engineering Content Management System

EIR - Exchange Information Requirement

EPC - Engineering Procurement and Construction

ERP - Enterprise Resource Planning

GUID - Globally Unique Identifier

GIS - Geographic Information System

HVAC - Heating Ventilation and Air Conditioning

IC - Implementation Committee

IDP - Integrated Data Processing

IDM - Information Delivery Introductory Book on BIM

IDS - Information Delivery Specification

IFC - Industry Foundation Class

ISO - International Standardisation Organisation

IT - Information Technology

LOA - Level Of Accuracy

LOF - Learning Outcomes Framework

LOI - Level of Information

LOD - Level of Development / Level of Definition (in UK)

MEPF - Mechanical, Electrical, Plumbing and Fire fighting

MIDP - Master Information Delivery Plan

MPS - Model Progression Specification

MR - Mixed Reality

MVD - Model View Definition

NIT - Notice Inviting Tender

OTL - Object type library

PIM - Project Information Model

PIR - Project Information Requirements

PLCS - Product life cycle support

RFI - Request For Information

RFP - Request For Proposal

R&D - Research and Development

SOP - Standard Operating Procedure

TIDP - Task Information Delivery Plan

VDC - Virtual Design and Construction

VR - Virtual Reality

CONTENT

1. Introduction

BIM has different definitions to different professionals. Some say BIM is a software application, others say it is a process for designing and documenting information on buildings. Some say it is a holistic approach to design, construction and maintenance of a building.

As Figure below indicates, BIM is many things and most likely, the construction industry has not yet realized its full capabilities. BIM is intertwined with technology, both hardware and software. As the technology evolves rapidly, BIM will also continue to evolve.

Figure 1.0 Perspectives of BIM for different Professionals

While there are different definitions of BIM, there is a common consensus that BIM is a process for combining information and technology to create a digital representation of a project. It integrates data from many sources and evolves in parallel with the real project across its entire timeline, including design, construction, and in-use operational information. There are three guiding pillars for BIM which are people, process and policy.

1.1 BIM to enable Collaboration

The core aspect of a BIM is that it aids easier collaboration among project stakeholders. Working as a collaborative team requires the development of better and more efficient ways of working to achieve shared goals. It brings about many advantages for the construction industry, such as improved communication and understanding, leading to greater productivity, quality and cost certainty. Ultimately collaboration results in better outcomes. Creating the right environment for a collaborative workflow requires consideration of Culture and behaviour, Process, Digital tools and the right forms of contracts.

A key success of collaboration hinges on the ability to communicate, exchange, update and use data between different project teams. This requires data to be interoperable. Essentially 'Interoperability' is the software's ability to exchange and make use of BIM data. For BIM data to be shared between several BIM software programs, interoperability is essential. Open BIM formats like IFC format can be utilized for the same. In other industries, interoperability is taken for granted. The success of the Internet wouldn't be as great had it not been for its development on open–non-proprietary standards. This allows for devices, services and applications to work together across a wide and dispersed network of networks.

1.2 Misconceptions

Common Misconceptions About BIM in India

MISCONCEPTION	REALITY
BIM is Only for Large Projects	BIM benefits projects of all sizes , from large infrastructure to smaller residential projects.
BIM is Just a 3D Modelling Tool	BIM is a comprehensive process involving integrated data management, collaboration, and lifecycle management, not just 3D modelling.
BIM is Too Expensive	While there are initial costs for software and training, BIM can lead to significant cost savings and efficiency improvements over time.
BIM Requires a Complete Overhaul of Existing Processes	BIM can be integrated gradually with existing workflows, allowing for incremental adoption and adaptation.
BIM is Only for Design and Construction Phases	BIM is useful throughout the entire lifecycle of a building, including operation and maintenance, which is vital for managing long-term assets.
BIM Guarantees Perfect Outcomes	BIM enhances coordination and reduces errors, but does not guarantee perfect results; successful implementation depends on proper use and data management.
BIM is Only for Large Firms	BIM is increasingly accessible to small and medium-sized firms in India, which can benefit from its efficiencies and improved project outcomes.
BIM is Too Complex to Learn	While BIM involves a learning curve, there are growing resources and training programs available in India to help users effectively adopt and use BIM.
BIM Will Replace Human Jobs	BIM changes job roles but creates opportunities for skilled professionals. It enhances job efficiency and opens new avenues for expertise in project management and data analysis.

Reference : The BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors by Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011).

1.3 Definitions of BIM & Model Types

Terminology can challenge team communication. To assist teams, CPWD has selected industry terms for models developed and submitted throughout the project lifecycle. Additional project terms are located in the BIM Dictionary (https://bimdictionary.com/).

Standard Definition BIM is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward.

1.3.1 Planning Model is a simple model used for preliminary studies, early project planning, and programming. Space and area tools are used to define programming needs, space calculations, schematic massing, blocking and stacking, massing for site location, and early energy analysis to rapidly explore multiple options. These models can be used as a basis for design development. Model here will be LOD 100.

1.3.2 Work in Progress Model are specific discipline models. Examples are architecture, structure, MEP. These models are federated for design development, and BIM Use execution. These models are used during project progress reviews. The reviewed and approved models are federated into the Design Intent Model. Model here will be LOD 200.

1.3.3 Design Intent Model supports design execution, decision support, clash avoidance, and final construction documentation. The Design Intent Model is a contract deliverable for submission to CPWD. The Design Intent Model contents are updated to reflect as- built conditions to become the Record Model. Model here will be LOD 300.

1.3.4 Construction Coordination Model is the further development of the Design Intent Model by the General Contractor team. Models are here integrated with time and cost for planning and monitoring. Model here will be LOD 350.

1.3.5 Fabrication Model These models are developed by the sub-contractors. Smaller digital mock-ups may be created by the construction team to detail specific elements, intersection of building conditions, or systems for constructability review. Model here will be LOD 400.

1.3.6 As-Built Model file is a contract requirement. It includes shop models and drawing information from trades and fabricators with the as-installed conditions. This file may also include point cloud data. Model here will be LOD 500.

1.3.7 Record Model is a contract requirement and is the basis of the CPWD facility management model. It is the Design Intent Model updated to show as-built locations. It does not have the same level of construction detail as the As- Built Model. It may be used by commissioning. Equipment data and other information is updated in this model. These are LOD 500+

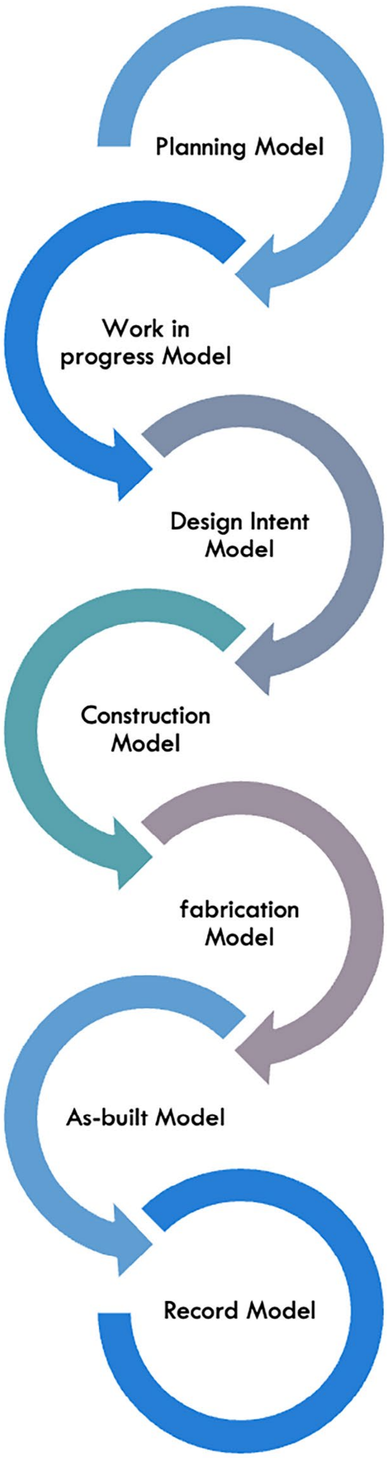


Figure 2: Model Types

1.4 Building the Information into Model

A BIM model may be thought of as an 'information model', a rich source of data containing graphical, non-graphical and linked documents. The model is progressively developed over the course of the project lifecycle. Typically, a model will go through a number of iterations.

Information models are an object-oriented design, consisting of elements or objects which have physical and functional characteristics attached to them as well as relation to nearby objects and spaces. BIM objects, the components that make up a BIM model, are intelligent, have geometry, and store data. If any element is changed, BIM software updates the model to reflect that change. This allows the model to remain consistent and coordinated throughout the entire process so that structural engineers, architects, MEP engineers, designers, project managers, and contractors can work in a more collaborative environment.

Information model of a single facility can consist of a one model file, or multiple model files where each separate domain model (architecture, structure, MEPF services etc.) are brought or federated together in the Common Data Environment (CDE) to present the single model of the asset. Each discipline is still responsible for their model and data.

The information model becomes an integral part of the decision-making process throughout the design, construction and management of the asset. To deliver this information and data, a clear strategy is applied together with a BIM process. The goal is to maximize the return on investment by defining a fluid flow of data use throughout the whole project life cycle. The client will get a more complete information, resulting in improved quality, efficiency and sustainable buildings. Within the BIM process, an information model is produced using BIM supported software. The model can be viewed and manipulated in 3D. Added to that is clash detection software, that detects clashes between and within individual construction parts, such as between utilities and structural elements. This achieves reduction in total operation cost, through improved design and therefore less modifications or clashes at the construction site. Thus making the constructed facilities, more reliable, maintainable and accessible.

Furthermore, the information model can be linked to scheduling software, enabling a better communication between contractors and other project participants. The project schedule becomes more reliable and the workflow more visual, which again makes the supply management of materials, equipment and workers more effective.

As the asset is designed, built, and managed, the information model plays a crucial role in the decision-making process. A BIM method is used in conjunction with a well-defined plan to offer these knowledge and data. The objective is to define a smooth flow of data consumption over the entire project life cycle in order to maximize return on investment. Better quality, more efficient, and sustainable structures will arise from providing the client with more comprehensive information. Using software that is enabled by BIM, an information model is created as part of the BIM process. One may view and work with the model in three dimensions. Software for detecting incompatibilities between and within individual construction components, such as between utilities and structural elements, has been added to that. Due to better design and fewer alterations or conflicts at the construction site, this results in a decrease in overall operating costs. As a result, the built facilities are now more dependable, maintained, and accessible.

Additionally, scheduling software and the information model can be connected to improve communication between contractors and other project participants. Again, this improves the effectiveness of the supply management of labour, materials, and equipment by making the project schedule more dependable and the workflow more visible.

1.5 Global Initiatives Driving BIM & Digital Transformation

The UN predicts that there will be 9.7 billion people on the planet by the year 2050. To meet global demand and contribute to the creation of places that are smarter and more robust, the global Architecture Engineering and Construction sector must turn to smarter, more efficient means of designing and building. Teams involved in design and construction can work more productively thanks to BIM, which also enables them to record the data they generate during the process for use in operations and maintenance. There are fifty BIM forums in more than forty countries worldwide as shown in figure 1. These BIM forums and councils are playing pivotal roles in promoting the adoption and integration of BIM framework in the global construction industry. Here are some noteworthy initiatives from different countries.

BIM Initiatives in India and Abroad

Organization	Founded	Region	Focus Area
Building SMART International	1994	Global	Global BIM standards and interoperability
Construction Industry Council, Hong Kong	2007	Hong Kong	BIM promotion and standards in Hong Kong
The BIM Task Group (UK)	2011	UK	UK BIM strategies and resources
Taiwan BIM Alliance	2012	Taiwan	BIM advancement in Taiwan's construction industry
Thailand BIM Association	2014	Thailand	BIM adoption and resources in Thailand
International BIM Summit	2015	Global	Global BIM best practices
BIM Serbia	2015	Serbia	BIM advancement and knowledge sharing in Serbia
India BIM Association	2016	India	BIM education and policy development in India
BIM Africa	2017	Africa	BIM development across Africa
Digital Building Collective	2018	Global	Digital transformation in construction
BIM4TURKEY	2018	Turkey	BIM integration in Turkey's construction and education sectors
BIMTECH Romania	2018	Romania	BIM research and development in Romania
Building Transformations Canada	2019	Canada	BIM and digital technologies in Canada
Indian Railways	2020	India	BIM for station development projects
National Capital Region Transport Corporation (NCRTC)	2020	India	BIM guidelines for project implementation and O&M
BIM Forum Brazil	2020	Brazil	BIM adoption and training in Brazil
Nepal BIM Forum	2020	Nepal	BIM research and implementation in Nepal
Public Works Department, Madhya Pradesh	2022	India	BIM mandate for contractors
BIS – BureAu of indian Standards (NAtional standards body for india)	2024	India	Indian Standards by BIS at National Level
NBC – 2025	2024-25	India	Elaborate BIM in Construction Management & Digitization as a special Part of NBC – 2025

Companies like Larsen & Toubro ECC are using 3D models and digital platforms to make their projects run smoother and keep subcontractors on the same page. While private companies have quickly adopted these digital tools, many government projects still use old-fashioned paper processes, which can slow things down. It's time for the government to embrace digital documents to speed up work.

For technology to really work, everyone in a company needs to be on board. Over the last few years, many businesses have become more digitally savvy, and the government is starting to catch up. Digital tools also help teams work better together. For example, the Eastern Peripheral Expressway was finished in 500 days instead of 900 thanks to improved digital teamwork. In short, moving to digital methods helps projects get done faster and more efficiently.

1.6 Impact and Benefits of BIM in AEC

Benefits of Implementing BIM & Digital techniques for the organization aspect can be evaluated in economic terms under the following eight categories. The potential benefits can only be augmented overall by implementing the ramp-up in phases, which demands an extended development and change process. The business centre and service units profit primarily from the acceleration of project execution and project quality improvements.

Figure 4. Benefits of BIM Implementation in AEC

1.6.1 Time Savings Asset delivery throughout each stage of the asset lifecycle, and in service delivery (or business as usual. For example, use of a Common Data Environment (CDE) enables easier ways of working and quicker information exchange.

1.6.2 Materials Savings Build, commission, operation, and end of life (maintenance, refurbishment, etc.) stages of the asset lifecycle, by reducing the volume of materials required (including reducing wasted materials).

1.6.3 Cost Savings In the asset lifecycle where it is difficult to distinguish the component time and materials elements. The benefits framework includes for example, cost savings from fewer changes, better clash detection, and improvements in facilities management and maintenance.

1.6.4 Health & Safety Improvement Build, commission, operation, and end of life stages of the asset lifecycle. For example, a 3D model provides the visual basis for improved staff briefing and training, with further potential provided through 4D-type simulations, (including construction and demolition activities), to optimize sequencing from a safety perspective.

1.6.5 Risk Reduction The use of BIM Level 2 has the potential to improve the accuracy of information about a project or asset, and improve visibility about associated costs, delivery timeline, and risks. Because of this increased certainty provided by BIM Level 2, there is a potential for a reduction in the variability of costs and time required for asset delivery and operation. This may result in the ability to reduce the contingency required against capital expenditure CAPEX and/or operating OPEX expenditure, thus resulting in a reduction in costs associated with that contingency.

1.6.6 Improved asset utilization The use of BIM Level 2 can improve the availability of an asset once it has been constructed: this means that it can potentially be used more productively over its lifetime to provide public services. Better space utilization planning; faster maintenance and refurbishment through use of an asset information model; and faster BIM enabled response to incidents; can all improve asset availability, or reduce an asset's downtime

1.6.7 Improve Asset Quality Improved visibility over the process of design and construction, which can enable improved quality of the asset for the end-user. For example, BIM's 3D and 4D visualization capabilities may result in a building being better laid out, or more pleasant to be in (the building may be angled to get more sunlight for example).

1.6.8 Improve Reputation Could potentially improve the reputation of construction clients and asset owners, and the supply chains involved in asset delivery; by improving the experience of those associated with asset delivery and service delivery. For example, in asset delivery, use of BIM Level 2 may result in better site layout and improved logistics. This could reduce (or avoid) negative impacts on residents, businesses and customers who reside near the construction site.

In summary, using BIM leads to greater construction efficiency, cost savings, improved quality and coordination, and better sustainability and asset management. The use of BIM is rapidly growing as its benefits are realized across the construction industry.

2. Understanding Classification of BIM Models

2.1 Level of Development

Terms like LOD100, 200, 300, 350, 400 and 500 are common in context with BIM Technology. This is an industry standard that defines how the 3D geometry of the building model can have more levels of refinement/ details included based upon the output desired from the BIM model. Thus, a Model at LOD100 will have far less details of the building than a model which has been created at LOD500.

These building model defined by its LOD level, is purpose built for various stages of Building Design viz 3D visualization, construction, quantities, scheduling, estimations, on-site production control and fabrication.

Described below in brief are the details generated for each LOD level. LOD definitions defined in the BIM forum Level of Development:

2.1.1 LOD 100 - CONCEPT DESIGN: The building 3D model is developed to represent the information on basic level. Thereby, only conceptual model creation is possible in this stage. Parameters like area, height, volume, location and orientation are defined.

This is helpful – Analysis & Site Monitoring / Massing Studies / Preliminary Creation of 3D Models / Spatial Relationships & zoning Compliance / Conceptual design Visualization

2.1.2 LOD 200 - SCHEMATIC DESIGN: General model where elements are modelled with approximate quantities, size, shape, location and orientation. We can also attach non-geometric information to the model elements. Non-geometric information can be embedded within model elements at LOD 200.

This is helpful in 3D Modelling – form & Layout / Conceptual design Development / Spatial Coordination& clash detection / Initial Energy Analysis / Preliminary Cost Estimation.

2.1.3 LOD 300 - DETAILED DESIGN CLASH FREE MODEL: By this level nearly all the Architectural, Structural and services are finalized and fixed in terms of requirements, sizes and layouts by the process of detecting and resolving clashes which occur between Civil Structure and Services. The building starts to appear in its final shape. The sizes of structural elements are fixed, pipes, ducts, shafts, building envelope, room sizes are finalized. The sizes of structural elements are fixed, pipes, ducts, shafts, building envelope, room sizes are finalized with precise quantity, size, shape, location, and orientation. Non-geometric information can also be embedded within model elements at LOD 300.

Detailed 3D modelling of building components/Accurate placement and sizing of components/ Coordination between trades (Architecture, Structural, and MEPF)/Complete clash detection and resolution/Quantity Take-off and Cost Estimation/Comprehensive simulations and energy analysis/Construction logistics and sequencing

2.1.4 LOD 350 - CONSTRUCTION DOCUMENTATION: This level includes finishing details, equipment descriptions for services and the model achieves a level from which information for construction documentation like GFC drawings, Quantities both RCC and finishing, Energy Analysis, Scheduling for planning and executions can be derived.

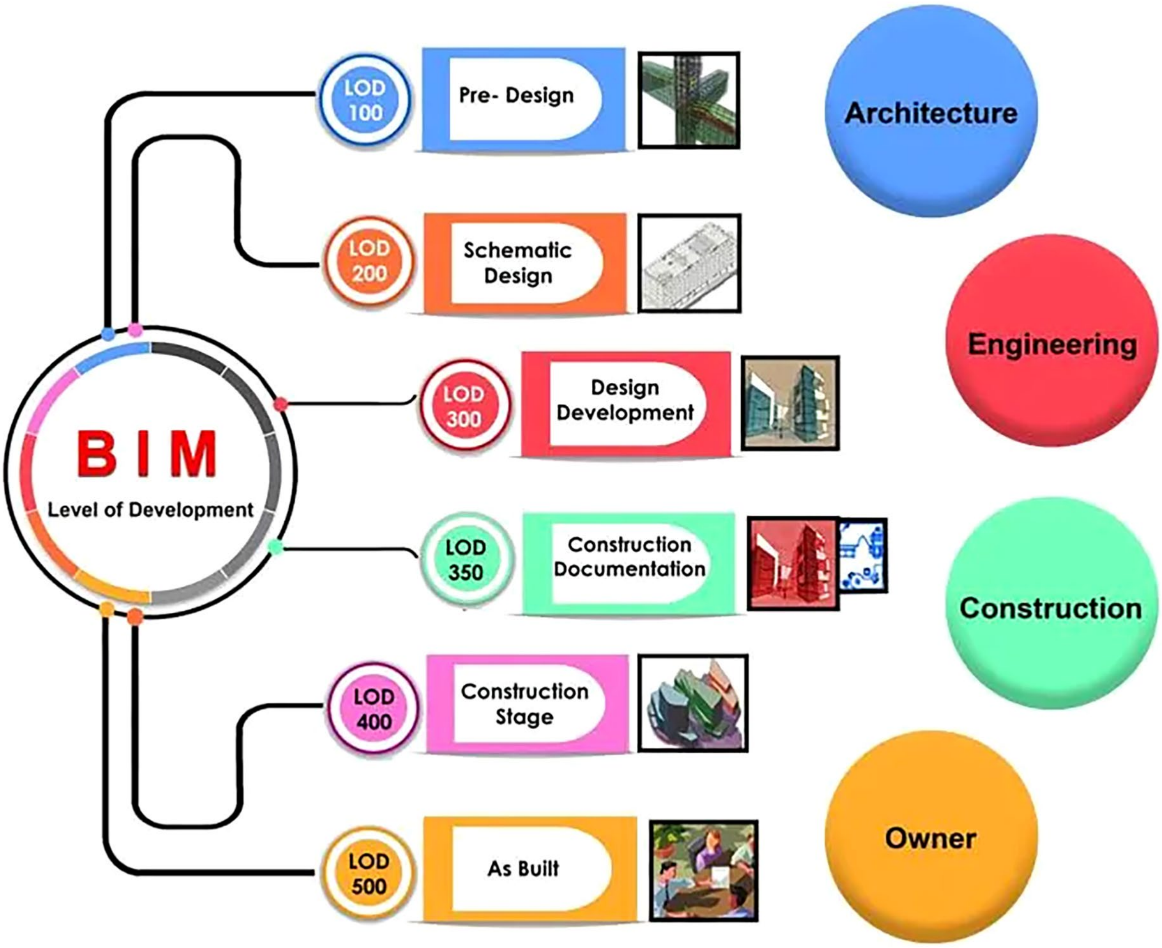


Figure 5. Level of Development

LOD 350 includes more detail and elements that represent how building elements interface with various building systems. It also provides clear graphics and written definitions.

Detailed 3D models with specific materials and products / Generate construction documents (specifications and drawings) / Coordinate multiple disciplines /Comprehensive cost estimation and quantity take-off /Accurate fabrication and assembly / Complete construction sequencing and accurate scheduling

2.1.5 LOD 400 - FABRICATION & ASSEMBLY: This level will include all information which is required either to create shop drawings or exact fabrication drawing. This model will assist production of fabrication ready details and Mechanised jobs like CNC cutting etc. This is a very advance stage of detail in the model. Non-geometric information can be embedded within model elements at LOD 400. This is a very advance stage of detail in the Modelling

Build 3D models for offsite fabrication/Create shop drawings and fabrication details/Integrate manufacturing processes/Develop component-level information to fabricate components/Plan prefabrication and construction

2.1.6 LOD 500 - AS-BUILT: In this LOD level, building elements are modelled as Built on site for Records, Maintenance and Operations. In addition to actual and accurate information about size, shape, location, quantity and orientation, non-geometric information is attached to modelled elements. This model can be an ideal tool to find out the deviation/changes from the original LOD300/350 level model.

Build accurate As-Built models to reflect actual construction / Generate detailed information about systems and components /Integrate operations and maintenance data / Perform lifecycle analysis and maintenance planning / Accomplish building performance analysis and monitoring.

BIM, which is still a relatively young technology, will eventually have a set of generally agreed the project. There are various distinct levels of BIM that may exist according to standards, and each has its own set of benefits and capabilities.

2.2 BIM Maturity Levels

BIM level depicts the maturity of the model.

- **BIM Level 0 – Low collaboration***:* This level of Building Information Modelling only includes 2D drawings using CAD (Computer Aided Design). Participants only share files, documents, drawings etc. via electronic prints and paper. There is no collaboration.
- **BIM Level 1 – Partial collaboration***:* It is not only about 2D drawings here, but 3-dimensional views are also considered. In level 1 BIM, teams are sharing information using a Common Data Environment (CDE). That allows them to collaborate easily on projects.

Nevertheless, there is still no collaboration (or low collaboration) between different disciplines, still each one owns its data and does not share it.

- **BIM Level 2 – Full collaboration***:* All participants are using their own 3D CAD models, but not necessarily working on a single, shared model. Collaboration occurs between different disciplines, by using a common file format i.e., IFC (Industry Foundation Class). IFC allows project's actors to access the data so everyone is able to work on the model.
- **BIM Level 3 – Full Integration***:* The level 3 of BIM is about full collaboration, that means every discipline collaborates through the same shared project. It includes 4D (construction sequencing), 5D (cost), and 6D (project lifecycle information). Everyone can access the data and edit it. This is what we call Open BIM.

2.3 BIM Standards

2.3.1 **ISO 19650**

ISO is largely developed around the world, but not developed the same way everywhere. To mitigate the differences, the goal was to provide international common standards. The ISO 19650 standard is an international standard for managing information over the whole life cycle of a built asset using BIM.

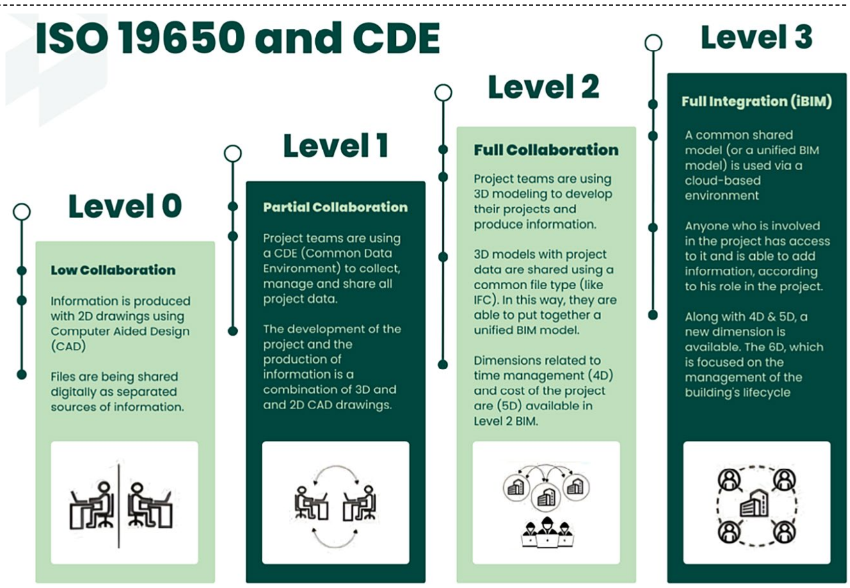


Figure 6. BIM Maturity levels

In an effort to form a common international standard base for the implementation of BIM, in December 2018, ES EN ISO19650 Series was published i.e., BS EN ISO 19650 1 & 2:2018 and in 2020, publication of BS EN ISO 19650 3 & 5:2020 was observed.

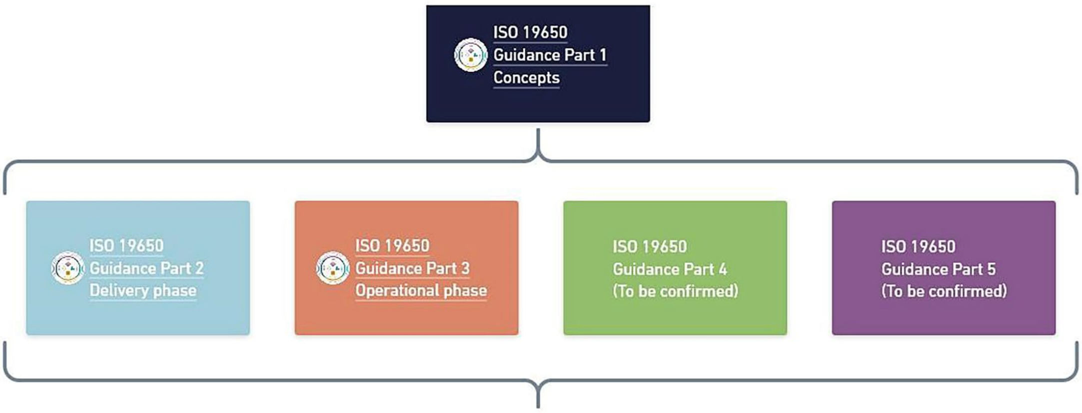
BS EN ISO 19650-1: Organization and digitization of information about buildings and civil engineering works, including BIM -- Information management using BIM: Concepts and principles (iso.org) (ISO 2018a).

BS EN ISO 19650-2: Organization and digitization of information about buildings and civil engineering works, including BIM -- Information management using BIM: Delivery phase of the assets (ISO 2018b).

BS EN ISO 19650-3:2020: Organization and digitization of information about buildings and civil engineering works, including BIM. Information management using BIM. Operational phase of the assets (ISO 2020a).

BS EN ISO 19650-4 - Organization and digitization of information about buildings and civil engineering works, including BIM - information management using building information modelling. Information exchange. Current Status - Under Development. Unlike Part 1-3, & 5 which provides governance and strategy around the execution of both the delivery phase, operational phase of information management and security aspect, ISO 19650-4 provides the explicit process and criteria for an individual information exchange and focuses on securing benefits from collaboration and interoperable building information modelling. It is currently under development as it is in its approval status with next being phase publication.

BS EN ISO 19650-5:2020: Organization and digitization of information about buildings and civil engineering works, including building BIM. Information management using BIM. Security-minded approach to information management (ISO 2020b).



source: UK BIM Framework (Marzia Bolpagni et al. 2021)

Figure 7. BIM Guidance for ISO 19650 Series

2.3.2 **BIS – BUREAU OF INDIAN STANDARDS**

BIS is massively engaged in delivering Indian Standards for BIM and the code is about to roll out soon. The BIS BIM code is a game-changer for India's infrastructure sector. By setting clear standards for Building Information Modelling (BIM), it will tackle common problems like project delays, cost overruns, and quality issues. This new code will make it easier for everyone involved—architects, engineers, contractors—to work together more smoothly. It will also help keep projects on track, within budget, and up to high standards. As India pushes forward with its ambitious infrastructure plans, this BIM code is set to improve efficiency, transparency, and the overall quality of construction, marking a significant step toward modernizing the industry.

2.4 Construction-Operations Building information exchange (COBie)

BIM process uses the Construction-Operations Building information exchange (COBie) standard to describe information for assets that are provided as part of a facility construction project. Using the BIM Projects program, the user may import COBie data files and manage the data as records for assets, locations, contacts, and task plans in Autodesk Docs. COBie data is a collection of data fields arranged in a spreadsheet with several worksheets and is defined in .CVS or .XLS files. A COBie table relates to each worksheet. The different COBie formats are: IFC, STP, XML, Spreadsheet ML, Cobie Lite and lastly Cobie as a spreadsheet – flat structure with references.

Prior to COBie, it wasn't necessary to specify the quality of the data delivered because the number of paper documents practically made it impossible to conduct anything more than a superficial assessment of the construction handover paperwork.

There are three sets of decisions owners can make to ensure that they get the information they need through COBie.

- The first step is to outline the categories they currently use to classify data from the Computerized Maintenance Management System. The Construction Specifications Institute's default categorization scheme is offered by COBie if there are no CMMS data.
- The second set of choices owners have is to restrict the assets that get scheduled information from COBie to just those that are controlled or maintained.
- Lastly, the owner can specify the particular qualities that should be required for each of these assets. Again, the default assumption is that the COBie data just mirrors the information on the drawing schedules. Such a degree of detail will often be far more in-depth than the data that is currently being gathered.

2.4.1 COBie as an efficient information exchange system

A project's facilities, spaces, floors, systems, installed equipment, and related paperwork, as well as specific information about other components, are all included in the COBie spreadsheet. A COBie sheet's entries are all hyperlinked to one another to improve value and facilitate information access.

The interconnectedness of a COBie spreadsheet's or data's entries streamlines and increases the efficiency of information sharing for all parties involved. Project managers, who are the end users, don't have to shift through mammoth stacks of Manual sheets or disorganized data to get information at various stages throughout a facility's maintenance lifecycle.

2.4.2 COBie Utility and Applications for Designers, Contractors, and Project Managers

The quality of the data delivered throughout the handover process has increased thanks to COBie. It is simpler for owners and other stakeholders, including facility managers, to evaluate the construction handover documentation as COBie organizes handover data in the digital format. Fundamentally, COBie requirements primarily serve three key stakeholders: designers, contractors, and facility managers.

2.4.2.1 COBie for designers

Designers find it simpler to align their designs with the COBie data thanks to COBie. The compiled collection of all the design schedules linked to all the drawings is included in the COBie data for designers. Designers may easily and immediately export COBie data associated with their designs using contemporary design tools. It is simpler for designers to adhere to COBie standards because all the major design tools support current COBie specifications.

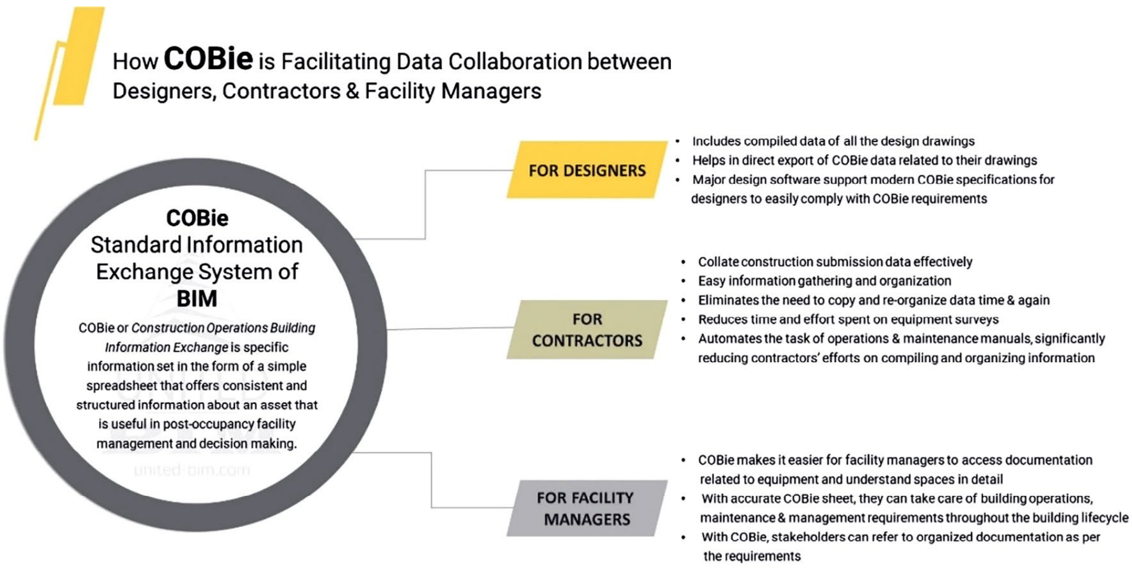


Figure 8. COBie for contractors

2.4.2.2 COBie for contractors

The effective collection of construction submittal data is made easier for contractors by COBie. By doing away with the need to repeatedly duplicate and reorganize data, COBie makes the process of obtaining and organizing information simpler. Additionally, COBie enables contractors to save time and effort on equipment surveys. Contractors may automate the creation of O&M Manuals using COBie, greatly decreasing the time and effort required to gather and arrange information for handover.

2.4.2.3 COBie for project managers

Project managers, users, and owners may more easily obtain equipment-related data and gain a thorough understanding of spaces thanks to COBie. Project managers may handle building operations, maintenance, and management needs starting on the day of handover by using a correctly formatted COBie sheet. Once the stakeholders switch to COBie, they are no longer

3. BIM & Digital Initiatives at CPWD

3.1 Formation Of Committee

Secretary MoHUA, during his address on 169th CPWD Annual Day on 12th July 2023, emphasized on exploring opportunities to use BIM extensively in CPWD's systems and buildings. Actionable issues / suggestions emerged from the speech of Secretary, MoHUA were issued vide OM date 19.07.2023.

Subsequently, a committee was constituted under the Chairmanship of Special DG (HQ), CPWD vide OM dated 24.07.2023, with ADG(Tech), ADG(Works), ADG(Training), DDG(Works), DDG(ERP), CE-CSQ(C/E), SDG/ADG of the region/ representative as members and Director (Tech &PR) as member secretary. The Committee was broadly assigned the task of devising strategies for implementation of BIM and adoption of relevant best practices. To this extent following mandates were given to the committee:

1. Identification & Evaluation of BIM software available in the market
2. Roles and responsibilities of various stakeholders including contractors.
3. Methodology for Procurement of different Software
4. License Management of the procured software
5. Integration of the software with ERP
6. Cost-Benefit Analysis
7. Training & Capacity building
8. Formulation of the guidelines for implementation of BIM in CPWD

To achieve the desired mandate, Committee has conducted several meetings and deliberations. Presentations were also arranged from various BIM software vendors, experts and academicians to better understand the current market scenario, inherent feature of various software, their pricing and potential, along with their suitability with current CPWD working environment.

Subsequently, Draft BIM Action plan and Draft BIM policy were issued vide OM dated 25.09.2023 and 01.11.2023 respectively, seeking feedback / suggestions from field units. Suggestions received have been evaluated and incorporated in these BIM guidelines.

3.2. BIM & Digitalisation Technologies

The adoption of BIM by CPWD holds the potential to significantly enhance collaboration, provide detailed visualizations, improve project efficiency, and streamline data integration, ultimately leading to cost and time savings. While various software options important for construction work are detailed, CPWD field units will have the flexibility to choose the most suitable ones for its specific needs and projects.

Detailed BIM Use Case Information

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
Category - 1: Existing conditions modelling			**Description :** Existing conditions modelling supports the aggregation and use of existing data for project modelling, studies, and options modelling.						
1.1	Project Site Modelling and Infrastructure Modelling	An existing ground surface model of the project site and any occupying or relevant structures and utilities affecting the project.	Conceptual Modelling Tool, BIM Model Authoring Tool, Model Federation Tool, Common Data Environment, Reality Capture Tool	Laser Scanner/LIDAR, Drones (UAVs), GNSS/Satellites GPR (All Frequencies), Total Stations, High-performance Workstations	Project Surveying Team, Design Team	RIBA Stage 0 - Strategic Definition, RIBA Stage 1- Preparation & brief	LOD 200 - Generic site element modelling, LOD 300 - Accurate for cut, fill, and volume estimations	Design models, Federated models in IFC or BCF format	CAD or GIS drawings, Google Earth photos, and scans
1.2	Surrounding Site modelling	Includes the area, Buildings, and infrastructure (roads, bridges, railroad, subways, streetcar lines) adjacent to the project site necessary for project analysis, review, or decision support.	Conceptual Modelling Tool, BIM Model Authoring Tool, Model Federation Tool, Common Data Environment, Reality Capture Tool	Laser Scanner/LIDAR, Drones (UAVs), GNSS/ Satellites, Total Stations, High-performance Workstations	Project Surveying Team, Design Team, BIM Manager	RIBA Stage 0 - Strategic Definition, RIBA Stage 1- Preparation & brief	LOD 100 - 200: CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-Up	BIM model integrated with project site model	Project Site Model, CAD or GIS drawings
1.3	Existing conditions – laser scanning	3D laser scanning (based upon approved survey control points) produces dimensionally accurate and detailed 3D point clouds (PC) of existing facilities and assets.	Conceptual Modelling Tool, BIM Model Authoring Tool, Model Federation Tool, Common Data Environment, Reality Capture Tool	Laser Scanner/LIDAR, Drones (UAVs), GNSS/ Satellites, Total Stations, High-performance Workstations	Project Design Team, BIM Manager	RIBA Stage 0 - Strategic Definition	LOD 100 - 200: CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-Up	3D point cloud, BIM(s) as specified in the BIMxP, Design models, Federated models in IFC or BCF format	CAD or GIS drawings, Google Earth photos, and scans
1.4	Existing conditions – interiors modelling	A spatially accurate model of existing spaces, building system components, and equipment	BIM Model Authoring Tool	Laser Scanner/ LIDAR, 360* Cameras, High-performance Workstations, Robots	Project Surveying Team, Design Team, BIM Manager	RIBA Stage 0 - Strategic Definition, RIBA Stage 1- Preparation & Brief	Assets and spaces are typically LOD 300	Design models in IFC format, QTO reports, COBie format, and source point cloud as backup for model validity	CAD Drawings
1.5	Geo-technical modelling	A visual, dimensionally accurate model of the geo-technical analysis report supporting project scope and requirements.	BIM Model Authoring Tool, Model Federation Tool	Laser Scanner/LIDAR, Drones (UAVs), GNSS/ Satellites, Total Stations, High-performance Workstations	Project Design Team, BIM Manager	RIBA Stage 0 - Strategic Definition, RIBA Stage 1- Preparation & Brief	LOD 100 - 200: CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-Up	Geotechnical model integrated with project site model	Geo- technical data, CAD and GIS drawings

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
1.6	Site modelling – Horizontal construction	Roadways, raised bridges and walkways, and transportation structures such as pedestrian tunnels are all examples of horizontal modelling needs.	BIM Model Authoring Tool, Model Federation Tool	Laser Scanner/LIDAR, Drones (UAVs), GNSS/ Satellites, Total Stations, High-performance Workstations	Project Surveying Team, Design Team	RIBA Stage 0 - Strategic Definition, RIBA Stage 1- Preparation & brief	Model Elements General description and LOD 200 - 350, Horizontal Structures LOD 300 – 350	3D Site Model, utilities in DWG format, and Structural Design model in IFC Format, Federated Model may linked to site model	A combination of CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-up
Category -2 : Design & Building System Authoring		**Description :** Design & Building System Authoring supports the modelling of Individual disciplines which are federated to create the Design Intent model of the final design solution.							
2.1	Architectural modelling	This model is used to explore design options, and serves as a base model for the federated design intent model, design analysis, and other BIM Uses	Conceptual Modelling Tool, BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architectural Team, Design Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200 – 300	Design Model, federated model in IFC/BCF Format for handover, used as basis for Record (As-Built) model	CAD Drawings
2.2	Space, Accessibility, and Circulation Requirements Modelling	To model space, circulation areas, and accessibility using accessibility standards, consistent modelling methods	Conceptual Modelling Tool, BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architectural Team, Design Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200 - 300	Space views and space reports for design meetings and communication during design development	CAD Drawings, Specifications and Standards
2.3	Structural Modelling	A model of the structural system of an existing or proposed design	BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Structural discipline model, shop drawings integrated into the structural model.	Structural Design Data, CAD Drawings
2.4	HVAC Mechanical Systems	A model of MEP system for decision support and analysis, made ready for detailing and fabrication	BIM Model Authoring Tool, Model Federation Tool, Model Checking Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 200 – Generic elements, LOD 300 – Detailed elements, LOD 400 – LOD 400 for field installation	Structural discipline model, clash avoidance among Architectural, Structural, and HVAC	MEP Design Data, CAD Drawings

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
2.5	Plumbing & Fire Protection	A model of Plumbing & Fire Protection system sufficient for shop modelling and fabrication	BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architectural Team, Design Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200 – 500 for As-Built (Record) Model	Discipline model, COBie data and commissioning information, construction drawings to A/E	CAD Drawings, Specifications and Standards
2.6	Electrical Alarm Systems	A model or part of the electrical model, the primary components of the electrical, lighting, alarm systems and building automation systems (BAS) controls	BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architectural Team, Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 200 - 300	Deliverables include discipline models, distribution panel schedules and other equipment schedules, sensor locations, COBie data	CAD Drawings, Specifications and Standards
2.7	Interiors	Modelling of interior design options, materials and finishes, systems, signage, and daylighting.	BIM Model Authoring Tool, 3D Modelling Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architectural Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Include renderings and model views as requested for design review.	BIM Architecture Model
2.8	Tenant Build-Out	Tenant projects include simple kiosks, office spaces, technical laboratory spaces, and other specialized-function spaces.	BIM Model Authoring Tool, 3D Modelling Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architectural Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Include renderings and model views as requested for design review.	BIM Architecture Model
Category - 3 : Analysis and reporting			**Description :** A major benefit of BIM is the ability to analyze the model for performance, design conformance, and to run reports of critical design information as the model changes.						
3.1	Area & Space Program Validation	The BIM file, specifically spaces and bounding elements, including floors and stories, is analyzed using model checking software	BIM Model Authoring Tool, Space Planning Tool, Model Checking Tool	High-performance Workstations	Architectural Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200 - 300	Space Area Model with Minimum space attributes	BIM Architecture Model

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
3.2	Design Options	Model with design options supporting the project program requirements	BIM Model Authoring Tool, Model Federation Tool, Solibri	BIM Experience Center, High-performance Workstations	Architectural Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 100 - 300	Structural discipline model, Clash avoidance between Architectural, Structural, and HVAC, Equipment lists	BIM Architecture Model
3.3	Model Checking - Program Compliance	Model Checking is a rules-based activity that automates model review for design program, modelling quality, data, and some code conformance.	Model Checking Tool	High-performance Workstations	Architectural Team, Design Team BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Model confirming to Codes and set rules	Populated BIM Model, Standards & Specifications
3.4	Clash Avoidance & Detection	Primary method to minimize interferences between building elements using "clash detection" software	Model Federation Tool, Model Checking Tool	High-performance Workstations	Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Clash Report between different disciplines Architectural, MEP	Populated BIM Model with Architecture, MEP, Structural elements
3.5	Structural Analysis	Model based analysis of structural design to determine fitness for use.	BIM Model Authoring Tool	High-performance Workstations	Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Structural analysis report and graphics for design reviews	Structural Design Data, CAD Drawings
3.6	Equipment and Maintenance Clear Space	This modelling covers major equipment and elements requiring defined access or maintenance space	BIM Model Authoring Tool, Model Federation Tool	High-performance Workstations	Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 400	BIM-based review with Facility Management	Populated BIM Model, Standards & Specifications
3.7	Budgetary Costing	Budgetary Cost uses BIM spaces, major building elements with historic square foot costing data, project type, region, and construction type, to calculate budgetary estimates.	BIM Model Authoring Tool, Data Management Tool, Construction Simulation Tool	High-performance Workstations	Planning Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200 – 300	Periodic costing reports for design options	Populated BIM Model, Cost data

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
3.8	Quantity Take-Off (QTO)	QTO serves as the basis for estimating. It provides professional estimators with quantities used, rather than quantities to be purchased.	BIM Model Authoring Tool, Construction Simulation Tool, Model Federation Tool	High-performance Workstations	Estimator, BIM Manager	RIBA Stage 3 - Developed Design	LOD 200 - 350	Provide in "scheduled" format (grid or spreadsheet), quantity listings for all elements	Populated BIM Model
Category - 4 : Sustainability, Energy, Green Certification			**Description :** BIM analysis to help achieve sustainable, resilience, and energy efficient designs on its projects						
4.1	Energy Modelling, Sun Studies, Day Lighting	BIM Model is analyzed to improve day lighting in design, to understand sun shading needs and the balance between daylight and artificial lights to support space usefulness	Energy Analysis Tool	High-performance Workstations	Architectural Team, Design Team BIM Manager	RIBA Stage 2 - Concept Design	LOD 200	Calculations, data, and visualization of the study. Analysis to be used in BIM-based reviews, and design option activities	BIM Architecture Model
4.2	Existing Building – Rapid Energy Modelling	Rapid Energy Modelling (REM) is a streamlined process for simplified simulation that quickly and with minimal data from existing building conditions develops an energy analysis	BIM Model Authoring Tool, Energy Analysis Tool	High-performance Workstations	Architectural Team, Design Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200	Energy Analysis Report from existing building conditions	Building Conditions, Architecture model
4.3	Mechanical Analysis	Virtual testing and balancing of the design model to support sustainable building systems design and analysis, calculate native heating and cooling analysis that is built into the MEP software	Energy Analysis Tool	High-performance Workstations	Design Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300	Native Heating and Cooling Analysis report exported to an external analysis application	Federated MEP Model, Meterological data
4.4	LEED Credit and Certification Reporting	BIM to identify, quantify, and cross-reference materials supporting LEED credits	BIM Model Authoring Tool, Energy Analysis Tool	High-performance Workstations	Architectural Team, LEED Coordinator, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200	Images, documentation, and reports as evidence of conformance for LEED certification	Federated BIM Model, LEED Specifications and Requirements

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
4.5	Lighting Analysis	Use Case has two objectives: LEED compliance and energy performance and comfort	BIM Model Authoring Tool, Energy Analysis Tool	High-performance Workstations	Architectural Team, LEED Coordinator, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200	Images, documentation, and reports as evidence of conformance for LEED certification	Federated BIM Model, LEED Specifications and Requirements
4.6	Systems Analysis	BIM is used to capture the building geometry and characteristics needed to conduct aspects of energy performance analysis and support contracting processes	BIM Model Authoring Tool, Energy Analysis Tool	High-performance Workstations	Design Team, BIM Manager	RIBA Stage 2 - Concept Design	LOD 200	A series of analysis reports identifying the options and the optimum solution for energy reduction	Federated BIM Model, Building Performance Requirements
Category - 5 : Design, constructability reviews & coordination			**Description :** BIM enables the design and construction teams to work in a Lean manner to maximize BIM use, communication, and coordination.						
5.1	BIM Based Progress Meetings, Reviews – "Big Room"	To minimize misinformation between team members, to reduce paper-based communication, and to focus attention on design decisions	Model Federation Tool, Construction Simulation Tool, BIM Model Authoring Tool, Common Data Environment	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	AE, CM/GC, and sub-trades – BIM Managers and Coordinators	RIBA Stage 4 - Technical Design	LOD 200 - 300	Design Reviews, Constructability Reviews, Shop Drawings, Construction Documents, Performance Review reports	Federated BIM Models corresponding to Meeting requirements
5.2	Digital Details, Mock-ups	Design Coordination Reviews, Constructability Reviews, Shop Drawings, Construction Documents, Energy and Performance Reviews, Change Management Reports, Cost Estimates, Value Analysis Reports	BIM Model Authoring Tool, MEP software, Drafting Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	Design Team, CM, BIM Manager	RIBA Stage 4 - Technical Design	LOD 200 - 300	Images, views, sub-models, integrated model sections, per the mock-up creation, and views to be integrated into the construction drawings	Federated BIM Models corresponding to Mock ups

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
5.3	Scheduling – 4D Modelling and Logistics	Construction coordination model supporting Look-Ahead, construction phasing, construction material movement, labor sequencing, site planning for material delivery, loading/unloading, staging, and storage	Model Federation Tool, Construction Simulation Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	CM/GC, Scheduler, Construction BIM Manager	RIBA Stage 5 - Construction	LOD 300	Updated 4D models as the project progresses, with updating, reporting, and delivery as set in BIMxP	Federated BIM Models corresponding to Scope of work
5.4	Site Safety Review	Integrating the project site logistics, materials and equipment use, vehicles, with load and delivery planning schedule data with BIM provides a means to see, prevent, and resolve conflicts.	Model Federation Tool, Construction Simulation Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for BigRooms, High-performance Workstations	CM/GC, Scheduler, Construction BIM Manager	RIBA Stage 5 - Construction	LOD 300	Deliverables include site views, animations, construction and logistics plans in PDF format as the project progresses security model, delivery schedules, and schedule updates	BIM Models with site logistics
5.5	In Field – Construction Layout	BIM is used as a basis for laser guided field layout of walls and building elements. BIM supports better construction layout.	Drafting Tool, BIM Model Authoring Tool	3D Scanner - LIDAR, Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	CM, Constructor and sub-trades, BIM Manager	RIBA Stage 4 - Technical Design	LOD 300	XYZ survey/layout point files for exchange with field layout equipment	Project features must be modeled to support this Use Case
5.6	Laser Scanning – Construction Phase	3D laser scanning performed during construction captures as-built work. This aids the team in change management captures newly built conditions prior to being covered and closed to view, and later will aid facilities operations in reliably locating systems components with a high degree of accuracy	Reality Capture Tool	3D Scanner - LIDAR, Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	CM, Constructor and sub-trades, BIM Manager	RIBA Stage 5 - Construction	LOD 300	Registered/ rotated/ elevated 3D point clouds conforming to the defined coordinate system	Coordinates for Survey Points, CAD Drawings

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
5.7	Pre-Fabrication Building Components	BIM Use Case includes Modelling the proposed building components with a focus on visualizing and simulating the logistics of their placement in a new or existing building, as well as the logistics of maintenance, repair and eventual replacement in situ.	BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for BigRooms, High-performance Workstations	CM, Constructor and sub-trades, BIM Manager	RIBA Stage 4 - Technical Design	LOD 400	Deliverables include schematics and animation sequences of prefabricated building components being transported, placed onsite, and installed	Federated BIM Model with site logistics
Category - 6 : Documentation, Drawing and Specs			**Description :** BIM enables drawings and construction sets to be derived from the model. The following BIM Uses support BIM use for more coordinated documentation during design and for record models at project turnover.						
6.1	Construction Drawing Production	Construction Documents (CDs) are derived from the model. Views are automatically generated in the BIM file by the authoring software.	BIM Model Authoring Tool	High-performance Workstations	A/E, Discipline Model Coordinators, sub-trades, BIM Manager	RIBA Stage 5 - Construction	LOD 300	Deliverables will be as per Drawing and Publishing requirements in the BIM Guidelines	Federated BIM Models corresponding to Scope of work
6.2	Shop Drawing Coordination	Detailed shop drawings for fabrication and construction are derived from the discipline specific design intent model.	BIM Model Authoring Tool	AV/Projector setups for Big Rooms, High-performance Workstations	A/E, Discipline Model Coordinators, sub-trades, BIM Manager	RIBA Stage 4 - Technical Design	LOD 400	Shop drawings with building elements, components, and parts according to the design intent model.	Federated BIM Models corresponding to Scope of work
6.3	AS-BUILT Models	BIM Models with AS BUILT construction Information	BIM Model Authoring Tool, External but Linked Databases, Model Federation Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	Design team, the constructor BIM Manager	RIBA Stage 5 - Construction	LOD 500	As Built models suitable for facility management	Federated BIM Models with AS BUILT information

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
6.4	Data Normalization	Data Normalization is essentially the task of preparing data to be usable by BIM systems in a consistent manner to provide consistent reports and analyses with minimum querying effort	Classification System, Data Management Tool, Database Management Tool	High-performance Workstations	Design BIM Manager, Constructor's BIM Manager, Commissioning agent	RIBA Stage 4 - Technical Design	LOD 300	BIM Record model with normalized data	COBie Database
6.5	AS-BUILT CAD Drawings for Handover	As-Built CAD drawings of all floor plans from the Record Model	BIM Model Authoring Tool, External but Linked Databases, Model Federation Tool	High-performance Workstations	Design team, the constructor BIM Manager	RIBA Stage 5 - Construction	LOD 500	As Built models suitable for facility management	Federated BIM Models with AS BUILT information
Category - 7 : Commissioning & Handover			**Description :** Commissioning of the BIM itself may be required according to specifications found in the BEP						
7.1	Virtual Handover (Record Model)	The virtual handover (record model) is the design intent model, updated with as-built locations for building elements within the model.	BIM Model Authoring Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for BigRooms, High-performance Workstations	Design team, the constructor BIM Manager	RIBA Stage 4 - Technical Design	LOD 300	The record model contains the necessary building element updates, product, space, and Facility Management data	Federated BIM Model
7.2	COBIE Data Set	COBie (Construction Operations Building Information Exchange) is a vendor-neutral flexible data specification that indicates how to format design and construction data so that they can be consumed by other facility software.	BIM Model Authoring Tool, Model Federation Tool, Model Checking Tool, Facility Management Tool	High-performance Workstations	Design team, the constructor BIM Manager	RIBA Stage 4 - Technical Design	LOD 300	Based upon the agreed upon assets to be defined in COBie, the team will populate the COBie worksheets per the schedule defined	Object Attributes for Type, Component, System, Space, Facility

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
7.3	Commissioning	Commissioning is a systematic process of verifying that all building systems perform interactively according to the design intent and the owner's operational needs	BIM Model Authoring Tool, COBie Data Management Tool, Facility Management Tool, Mobile BIM Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for BigRooms, High-performance Workstations	Design team, the constructor BIM Manager, Commisioning Agent	RIBA Stage 6 - Handover & Closeout	LOD 500	Record Model updated with data requirements on major assets and spaces and project construction documentation supporting the commissioning process	Federated BIM Model with As Built Information
7.4	Model Data Supporting Disaster Planning	BIM use and GIS data for Master Planning studies that include considerations for disaster planning	BIM Model Authoring Tool, GIS, Model Federation Tool, Model Simulation Tool	High-performance Workstations	Design team, the constructor BIM Manager, Security Consultant	RIBA Stage 3 - Developed Design	LOD 300-350	Deliverables include simulations, model views supporting design options during design and master planning, assumptions, and some degree of structural analysis	BIM Model, GIS Data
7.5	Model for Maintenance and Maintenance Training	The models are used during commissioning, preoccupation, and post-occupation to train staff on asset location, maintenance access, and maintenance procedures.	BIM Model Authoring Tool, Facility Management Tool, Common Data Environment, Mobile BIM Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	commissioning agent, the facility manager, and constructor's BIM manager.	RIBA Stage 7 - In Use	LOD 500	Asset Information Model for Facility Management	Federated BIM Model with As Built Information
Category - 8 : Facilities & Data Integration			**Description :** BIM may be used in the field for efficient data collection. Facilities data from the BIM model can be integrated with BAS						
8.1	Assessment Models	BIM may be used in the field for efficient data collection.	Existing BIM Models, Facility Management Tool, Common Data Environment	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	BIM capable assessment team, BIM Manager	RIBA Stage 5 - Construction	LOD 300	Updated BIM models, Assessment Reports, and Database for integration with Facility Management Tools	Federated BIM Models corresponding to Scope of work

S. No	BIM Use Case	Description	Softwares	Equipment	People	Project Life Cycle Stages	Level of Development (LOD)	Deliverables	Data
8.2	Space Planning – Move Management	The design and space planning team will utilize BIM and intelligent objects to manage space, occupancy and use.	BIM Model Authoring Tool, Space Planning Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Architecture Team, BIM Team	RIBA Stage 7 - In Use	LOD 500	IFC model	Federated BIM Model with As Built Information
8.3	Security	BIM can be used for security studies on public and institutional, prisons, judicial, and health care facilities.	BIM Model Authoring Tool, Model Federation Tool, Model Checking Tool, Model Simulation Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Design BIM Manager, Constructor BIM Manager, Security and/ or CPTED consultant	RIBA Stage 4 - Technical Design	LOD 500	Deliverables include model views, animations, and simulations supporting security review	Federated BIM Model with As Built Information
8.4	CMMS and CAFM Data Model Integration	BIM Models can be used for effective Computerized Maintenance Management System and Facility Management	BIM Model Authoring Tool, Facility Management Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	BIM Manager, project managers and facility managers	RIBA Stage 7 - In Use	LOD 500	IFC model	Federated BIM Model with As Built Information
8.5	Resiliency Modelling	Visualization and simulation can be used to support land use policies and help analyze first responder data and access prior to determining a final strategy	BIM Model Authoring Tool, Model Federation Tool, Model Simulation Tool	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	Design Team, GIS Team, BIM Manager	RIBA Stage 3 - Developed Design	LOD 300-350	Animations and Simulations for BIM and GIS, and IFC models for exploration	BIM Model, GIS Data
8.6	Building Automation Systems BAS Integration	Integration of BIM graphics (2D & 3D) as spatial location points for building system sensor data. This is used for real-time displays of system activities.	Building Automation System	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets, High-performance Workstations	BIM Manager, project managers and facility managers	RIBA Stage 7 - In Use	LOD 500	IFC model	Federated BIM Model with As Built Information

3.3. Roles and responsibilities of various stakeholders

BIM tasks and roles as per Construction Phases

1. Initiation phase

BIM Tasks	Roles
Facilitate the development of a project BIM brief	BIM manager (design)
Define, complete and update the BIM execution plan	BIM manager (design), BIM coordinator (design)
Identify BIM standards	BIM manager (design), BIM coordinator (design)
Facilitate the identification and implementation of BIM standards	Model manager
Define project BIM protocols	BIM coordinator (design), BIM facilitator (design)
Establish project information requirement and information protocols	Information manager (design)
Coordinate BIM tasks in design discipline	BIM coordinator (design)
Provide guidelines to the team on agreed project rules	BIM coordinator (design)
Provide design guidelines to the team on project rules as agreed	Model manager
Communicate BIM vision to the team	BIM manager (design)

2. Planning & Design Phase

BIM Tasks	Roles
Establish asset information requirements and the process to maintain the asset information model	Information manager (design)
Coordinate and organize BIM training and workshops	BIM manager (design), BIM coordinator (design), BIM facilitator (design)
Coordinate modelling standards among the project team	Model manager
Manage all the graphical model development related tasks and non-graphical model development related tasks in accordance with BIM execution plan	BIM manager (design), BIM coordinator (design), BIM facilitator (design)
Create, coordinate & extract design drawings from BIM models	Model manager, BIM modeler
Coordinate all technical discipline and trade-specific BIM activity, i.e., tools, content, standards, requirements	BIM coordinator (design)
Lead the BIM documentation and analysis efforts of the internal project team	BIM coordinator (design)
Perform internal model reviews and interdisciplinary checks	Model manager
Oversee the fully integrated set of project models from all disciplines	BIM manager (design), BIM coordinator (design)

Coordinate multidisciplinary tasks	BIM manager (design), BIM coordinator (design), Model manager
Assure assembling of merged models	BIM manager (design), BIM coordinator (design), BIM facilitator (design)
Assure and inspect the functionality of merged models and the integration of the design models	Model manager
Carry out clash detection and resolution activities	BIM manager (design), BIM coordinator (design), Model manager
Manage model transfer and version control	BIM manager (design)
Schedule, coordinate, and facilitate BIM meetings for the design and construction team as well as all design disciplines	BIM manager (design), BIM coordinator (design)
Participate and coordinate in internal BIM meetings	Model manager
Prepare project outputs and revise them regarding quality assurance (QA) and quality control (QC) protocols	Model manager, BIM modeler
Assist in the preparation of project outputs	BIM manager (design), Information manager (design)
Coordinate with the construction manager on the BIM execution plan	BIM manager (design)

3. Construction Phase

BIM Tasks	Roles
Create BIM execution plan in coordination with the design team	BIM manager (construction), BIM coordinator (construction)
Establish software protocols for efficient BIM delivery	BIM manager (construction)
Coordinate software training	BIM manager (construction)
Coordinate sub-contractor BIM development	BIM manager (construction)
Integrate and coordinate the construction schedule with developed models	BIM manager (construction)
Integrate 3D fabrication models with the updated design model to ensure compliance with the design intent	BIM manager (construction), BIM facilitator (construction)
Carry out clash detection and resolution activities	BIM manager (construction)
Schedule, coordinate, and facilitate BIM meetings for the design and construction team and all design disciplines	BIM manager (construction), BIM coordinator (construction),BIM facilitator (construction)
Update models for shop drawings development	BIM coordinator (construction)
Create construction and as-built models	BIM coordinator (construction)
Prepare as-built BIM	Model manager
Coordinate data extraction sets	BIM manager (construction), BIM facilitator (construction)
Coordinate model commissioning and data handover	BIM manager (construction)

4. Monitoring and Control Phase

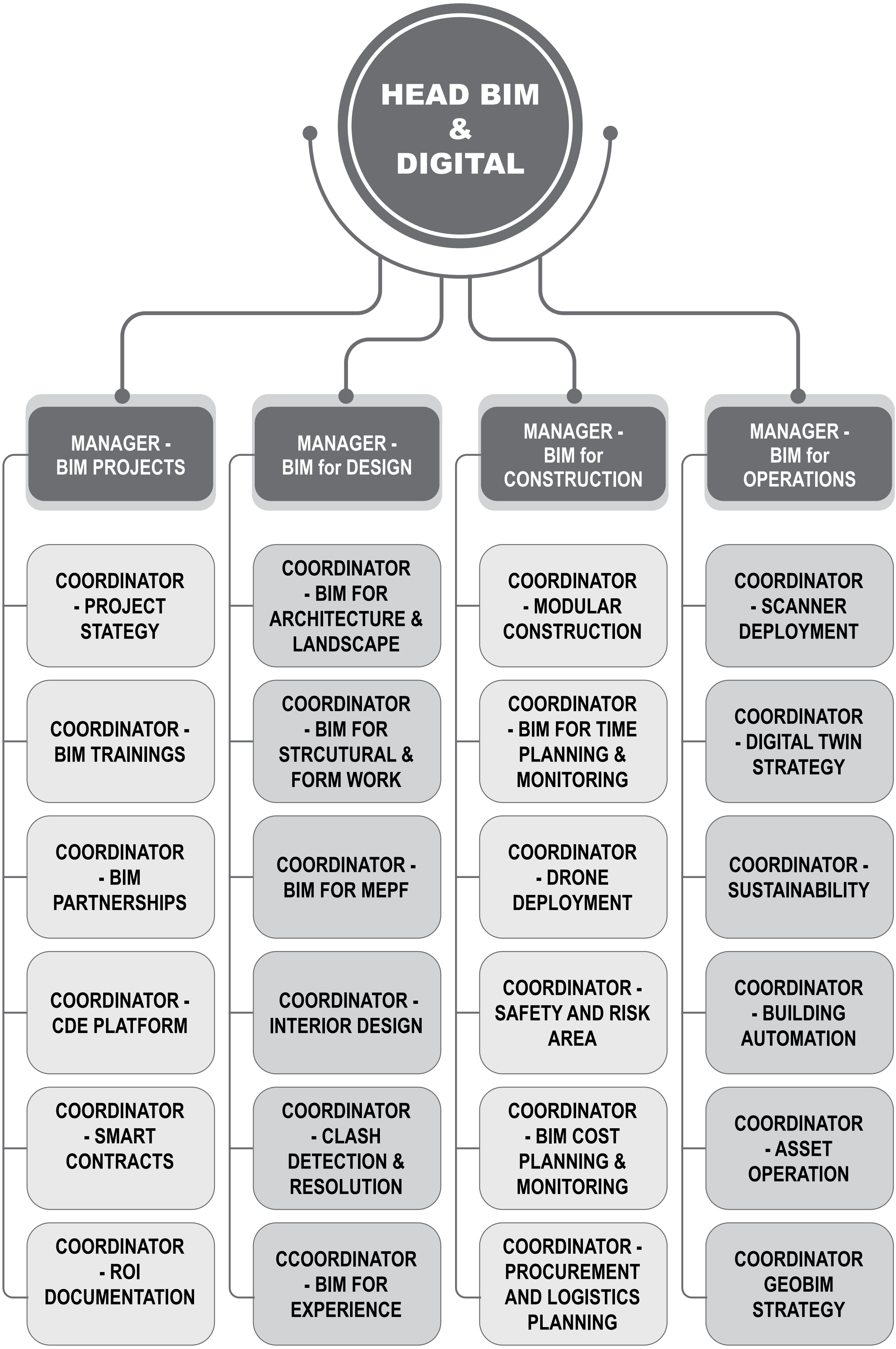
Implement and manage the BIM process, i.e., the BIM execution plan	BIM manager (design), BIM manager (construction), BIM manager (design and construction)
Participate in the updating of the BIM plan	Model manager
Ensure compliance with the BIM execution plan	BIM manager (design and construction), BIM coordinator (design and construction)
Ensure compliance with standards	BIM manager (design), BIM coordinator (design), Task information manager
Ensure BIM protocols implementation	BIM coordinator (design), Information manager (design)
Verify that all necessary configurations required for the seamless integration of design and construction model information have been implemented	BIM manager (design)
Ensure the accuracy of construction documents in accordance with discipline BIM Modelling	BIM modeler
Ensure document management	BIM manager (design)
Ensure software installation, operation, and version control	BIM manager (design and construction), BIM facilitator (design and construction)
Ensure software operation	Model manager
Develop & maintain graphical and non-graphical models in accordance with the BIM execution plan	BIM modeler
Monitor model production and updating	BIM coordinator (design and construction), BIM facilitator (design and construction)
Manage model production and updating	Model manager
Brief, assist, and coordinate with stakeholders	BIM manager (design and construction), BIM coordinator (design and construction)
Assist in coordination with stakeholders	Model manager
Communicate/Coordinate BIM issues with other members	BIM manager (design and construction), BIM coordinator (design and construction)
Manage the BIM resources (hardware, software, and people)	BIM manager (construction)
Ensure BIM is used appropriately to test design requirements/criteria	BIM manager (design), BIM facilitator (design)
Perform and manage the QA and QC of models	BIM manager (design), BIM coordinator (design)
Look after design discipline-based QA and QC of models	Model manager
Coordinate update of as-built conditions in the final model deliverable	BIM manager (construction)
Adhere to the projects BIM deliverables and their submission	Model manager
Ensure final BIM deliverable requirements are achieved	BIM manager (design)

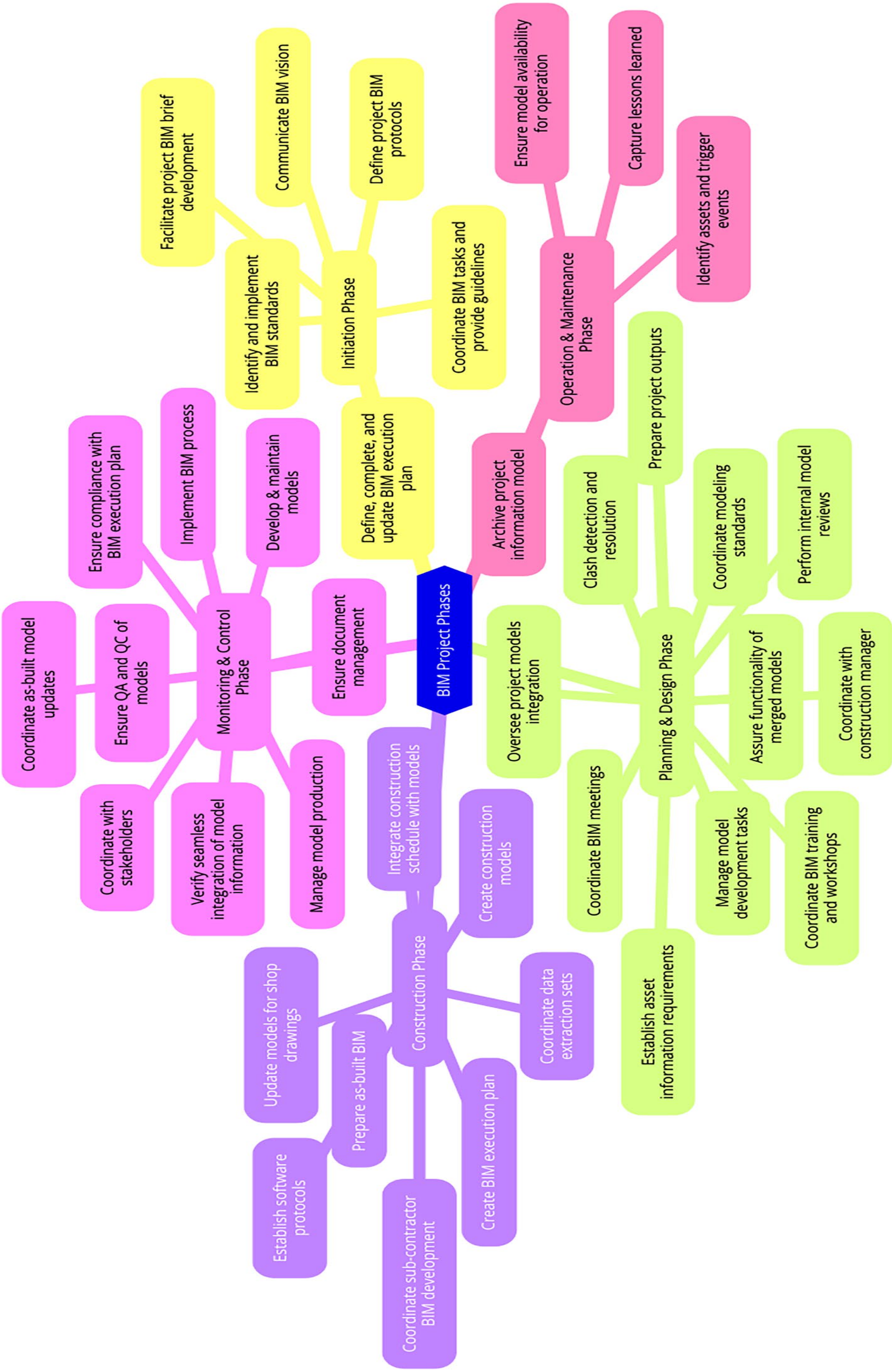
Maintain local file transfers, control of access lefts, and compilation of information from smaller models of other members	Model manager
Manage digital outputs, data transmission, and archiving	BIM manager (design), Information manager (design), Model manager
Facilitate, plan, and manage interoperability issues	Model manager
Manage interoperability issues	BIM coordinator (design), BIM facilitator (design)
Enable integration and coordination of information within the information model	Information manager (design), Information manager (construction), Information manager (design and construction)
Coordinate to assure completeness of interoperability information	BIM manager (design), BIM manager (construction), BIM manager (design and construction)
Ensure interoperability information is provided for milestone submittals	BIM manager (design), BIM facilitator (design)
Liaise with the client's facilities management department to determine specific data and file exchange requirements	BIM manager (design)
Maintain exchange information requirements	Information manager (construction)
Initiate and implement the project information plan and asset information plan	Information manager (design)
Enable reliable information exchange through a common data environment	Information manager (design)
Manage the processes and procedures for information exchange on projects	Information manager (design)
Ensure that the information exchanged between the different stakeholders corresponds to the rules fixed by the contract	BIM manager (design)

5. Operation and Maintenance Phase

Archive the project information model	Information manager (construction)
Ensure information and model availability for operation and maintenance	BIM coordinator (construction)
Identify assets (model and physical) and the foreseeable trigger events for which information should be managed	Information manager (construction)
Capture lessons learned for future projects	Information manager (construction)

BIM is a complex workflow process, and it is important that everyone involved in the project understands their role in making it a success. Clear roles and responsibilities of all stakeholders are important for ensuring that BIM is used effectively on a project. The chart below states likely structure of BIM implementers and detailed roles of each are mentioned in Annexure 1.


HEAD BIM & DIGITAL
MANAGER - BIM PROJECTS
COORDINATOR - PROJECT STATEGY
COORDINATOR - BIM TRAININGS
COORDINATOR - BIM PARTNERSHIPS
COORDINATOR - CDE PLATFORM
COORDINATOR - SMART CONTRACTS
COORDINATOR - ROI DOCUMENTATION
MANAGER - BIM for DESIGN
COORDINATOR - BIM FOR ARCHITECTURE & LANDSCAPE
COORDINATOR - BIM FOR STRCUTURAL & FORM WORK
COORDINATOR - BIM FOR MEPF
COORDINATOR - INTERIOR DESIGN
COORDINATOR - CLASH DETECTION & RESOLUTION
CCOORDINATOR - BIM FOR EXPERIENCE
MANAGER - BIM for CONSTRUCTION
COORDINATOR - MODULAR CONSTRUCTION
COORDINATOR - BIM FOR TIME PLANNING & MONITORING
COORDINATOR - DRONE DEPLOYMENT
COORDINATOR - SAFETY AND RISK AREA
COORDINATOR - BIM COST PLANNING & MONITORING
COORDINATOR - PROCUREMENT AND LOGISTICS PLANNING
MANAGER - BIM for OPERATIONS
COORDINATOR - SCANNER DEPLOYMENT
COORDINATOR - DIGITAL TWIN STRATEGY
COORDINATOR - SUSTAINABILITY
COORDINATOR - BUILDING AUTOMATION
COORDINATOR - ASSET OPERATION
COORDINATOR GEOBIM STRATEGY


BIM Project Phases
Initiation Phase
Facilitate project BIM brief development
Communicate BIM vision
Define project BIM protocols
Coordinate BIM tasks and provide guidelines
Identify and implement BIM standards
Define, complete, and update BIM execution plan
Operation & Maintenance Phase
Ensure model availability for operation
Capture lessons learned
Identify assets and trigger events
Archive project information model
Planning & Design Phase
Prepare project outputs
Clash detection and resolution
Coordinate modeling standards
Perform internal model reviews
Oversee project models integration
Assure functionality of merged models
Coordinate with construction manager
Coordinate BIM meetings
Manage model development tasks
Coordinate BIM training and workshops
Establish asset information requirements
Monitoring & Control Phase
Ensure compliance with BIM execution plan
Implement BIM process
Develop & maintain models
Ensure document management
Coordinate as-built model updates
Ensure QA and QC of models
Coordinate with stakeholders
Verify seamless integration of model information
Manage model production
Construction Phase
Integrate construction schedule with models
Create construction models
Update models for shop drawings
Prepare as-built BIM
Coordinate data extraction sets
Establish software protocols
Create BIM execution plan
Coordinate sub-contractor BIM development

3.4. COST BENEFIT ANALYSIS

Building information modelling (BIM) deployment requires an upfront cost, but the Return on cost ROI (Return on Investment)) realized from its use can be measured and is significant. According to studies, there are considerable long-term advantages that outweigh the initial expenditures, which varies depending on the project's scope and the size of the business.

Efficiency improvements are particularly noticeable in the construction industry across several locations. Up to 15% less rework on projects has been seen when using BIM, which translates into direct cost savings of 4% to 6% of the overall project budget. BIM was utilized for the complex planning and coordination of the Delhi International Airport Terminal 3 project, which is estimated to have reduced project costs by 5%.

BIM has demonstrated to be quite successful in terms of accuracy and collision detection. BIM was used on the Mumbai Metro Line 3 project to coordinate intricate subterranean utilities, potentially saving $15 million in rework costs and delays brought on by conflicts. Similarly, BIM was used to optimize the building sequences for the Shanghai Tower project in China, which reduced construction time by 30% and saved an estimated $58 million.

The predictive analytic capabilities which are included in BIM have also proven to be quite valuable. Operational expenses can be reduced by up to 25% using energy simulations and better material use. BIM was used to improve energy-efficient designs for the Godrej Eternia project in Chandigarh, which resulted in a 22% decrease in energy use when compared to conventional techniques.

Several associated parameters on which BIM directly aids in cost reduction are as under:

Reduction in Rework Costs: BIM enables comprehensive 3D modelling, clash detection, and virtual walkthroughs, which help identify issues before construction begins. This leads to a significant reduction in rework costs by addressing and rectifying problems during the planning and design phase rather than on the construction site.

Enhanced Project Efficiency: BIM streamlines project planning, design, and execution by improving collaboration and communication among stakeholders. This efficiency reduces project duration, which, in turn, lowers labour costs, equipment costs, and overhead expenses.

Accurate Quantity Take-offs: BIM allows for precise and automated quantity take-offs. This accuracy helps in better cost estimation and resource allocation, reducing the risk of cost overruns.

Resource Optimization: BIM assists in optimal resource allocation, ensuring that materials and labour are used efficiently, reducing waste and associated costs.

Improved Decision Making: BIM provides real-time data and simulations, enabling informed and timely decision-making. This leads to better resource allocation and reduces costs related to incorrect or delayed decisions.

Reduced Legal and Liability Costs: By providing a clear and accurate project record, BIM can reduce legal and liability costs associated with disputes, claims, and errors during construction.

Lifecycle Cost Savings: BIM's data-rich models extend beyond the construction phase, supporting efficient facility management and maintenance. This can lead to long-term cost savings by optimizing operations and minimizing repair and maintenance expenses.

Reduced Paper and Printing Costs: The shift from traditional 2D drawings to digital BIM models reduces paper and printing costs significantly.

Sustainability and Energy Savings: BIM can help in designing more energy-efficient buildings, leading to lower operational costs over the lifespan of the structure.

3.5. LICENSE MANAGEMENT

To efficiently manage BIM software licenses, it's recommended to negotiate with BIM software providers for multi-user licenses with a minimum validity of three years. Centralized management and access can be achieved by hosting the licenses on dedicated server owned by CPWD and meant for license management.

Alternatively, BIM software provider can offer a dedicated cloud space for CPWD for license hosting in order to manage, monitor and assign license to project team as required, provided the location of server is kept within geographical boundary of India. At any point of time, online license management portal should give graphical report on day wise or department wise to check actual license utilization and further its optimization. Nodal officer from CPWD headquarter / regional headquarter may be nominated for administration of users on centralized license management server for accessing licensed BIM software.

3.6. INTEGRATION WITH ERP

CPWD has initiated the implementation of integrated ERP systems aimed at automating workflow of construction processes from project inception to completion. CPWD ERP system incorporates BIM for collaboration, viewing of the models, combining of the models, marking of the issues, assigning of the task, administration of the users, managing of documents / models / drawings, Quantification (take off) of the components, Estimation and Scheduling, visualisation of project progress by integrating with other ERP applications. BIM authoring tools for architectural, MEPF, structural modelling, and clash detection etc are not part of CPWD ERP application. Architectural, structural, MEPF BIM models can be authored by respective stakeholders on any of BIM compatible authoring tool which can be uploaded on CPWD ERP collaboration platform for other BIM related activities.

CPWD ERP collaboration platform is web browser-based collaboration platform with the capabilities where models, drawings, documents can be swiftly exchanged among the various stakeholders and stakeholder can view the document, drawings and models through the web browser without any licenses and having the need to install the software in their computers/ laptops. Most of the file types of the software available in the market have been made compatible with Collaboration tool. This will essentially, be enabling all the stakeholder, to give their feedback on a detailed model/ create markups etc on a Realtime basis.

Similar to folder and file system, the project in-charge can create as many spaces as per the requirement for each category of stakeholders and assign owner of each space. Each space can have multiple users and folders as per the requirement. Members of each space can collaborate among themselves for deliberations without informing to the stakeholders of other spaces. Inter-space collaboration can be done by transmittals.

When linking all the models together and running a clash free detection, a separate project space should be created in the project and this space will host all the models. Every discipline working on the linked file will be able to check for clashes and the relevant changes can be made. The version control of the models / drawing / document and making available with latest version of each model / drawing / document with each stakeholder enables stakeholders to work on latest version.

CPWD has further issued guidelines on the quantity extraction as well as scheduling from BIM models using Collaboration & Estimation Module of ERP.

3.7. RECOMMENDATIONS OF BIM COMMITTEE

Based on these meetings/ presentations/ discussions, the committee has made thorough deliberations on the mandates and reached the outcome as given below. The outcomes of the committee's meetings and deliberations have been firmly established and provide a solid foundation for the ongoing efforts to effectively implement BIM within CPWD's operations and projects. At appropriate stages, relevant LOD models will be developed and standardised, for better workflow. However, challenges such as standardization, training, and infrastructure development need to be addressed.

A. Provision of BIM in Contracts and Manual

Provisions of CPWD works Manual, SOPs and General Conditions of the Contracts plays a pivotal role by means of compliances by CPWD employees and contractors/ consultants engaged for planning and construction works. Therefore, provisions of CPWD works Manual, SOPs and General conditions of the contract shall be reviewed and suitable provisions need to be modified / inserted for enforcing the BIM based construction and maintenance of infrastructures being created across the country by CPWD.

The model pre-qualification / eligibility criteria stipulated in CPWD works Manual / SOPs should have experience of construction of buildings with BIM models. Additionally, as part of site engineers the provisions for BIM trained engineers should also be stipulated.

NIT approving authorities have been entrusted with incorporation of suitable necessary provision in the RFPs / NITs / Bid documents for BIM based construction in the EPC contracts. In order to ensure uniformity across all the EPC contracts, a model conditions of the contracts for BIM based construction should be prepared in consultation with CE(CSQ) Electrical and circulated by Chief Engineer (CSQ) Civil.

The CPWD enlistment rules should incorporate requirement of BIM trained engineers with the eligibility requirement.

B. Capacity Building

BIM requires specialized skills and knowledge that are not typically covered in traditional education or training programs. Capacity-building initiatives should provide individuals with the necessary training and knowledge to become proficient in BIM technologies and practices. This includes understanding BIM software, data management, collaboration, and project management within a BIM framework. Leading BIM software providers should be invited to provide training for architects, engineers, and even vendors. The National CPWD Academy in Ghaziabad and the RTIs in Mumbai, Kolkata, and Chennai should serve as BIM Centres of

Excellence for capacity building. SOP should be developed for time-bound capacity-building measures, comprising both awareness and hands-on training.

MOUs may be signed with interested BIM software providers for capacity building of CPWD architects and engineers and for incorporating CPWD's DSR items into the software's library database.

A comprehensive framework is being developed to facilitate BIM collaboration, data exchange, quality controls, security, and seamless integration of BIM authoring tool across all disciplines, with the ERP system and published Schedule of Rates

It is understood by the committee that the Architects & Engineers of CPWD needs to be made aware of various modules of software and their applications in BIM implementation. The process will be time taking and proficiency cannot be expected in couple of days. To streamline this process, it has been decided to give holistic training on different software modules used for preparing a BIM model.

Also, to effectively impart training, 5 days sessions will be conducted at National CPWD Academy, Ghaziabad and at RTIs of Bombay, Chennai & Kolkata, for each discipline i.e. Architecture, Civil and E&M. As hands-on training on each discipline rather than a generic training session will be effective and useful. It is the understanding of the committee that all the software applications/ functions taught with in a span of 5 days may not be enough and specialized training may also be required with for 1-2 weeks.

By adhering to such step-by-step capacity building of the CPWD employees, we will be able to switch from 2D CAD models to LOD 100 BIM models and will soon be able to create LOD 300 models and gradually shifting to LOD 400 models.

To effectively build the capacity of officials, a step-by-step procedure should be implemented. The first step will involve conducting BIM virtual awareness sessions. Those who successfully complete this initial step will then proceed to the next phase, which will consist of hybrid training at Ghaziabad training institutes or at the centres specified by CPWD in metropolitan cities, then next a specified proficiency training session will be conducted. Finally, those who have undergone the training will be tasked with training others within their respective units.

In pursuit of advancing its Building Information Modelling (BIM) practices, CPWD has initiated a pilot program for the 360° Photo Documentation System in two ongoing projects. This technology, seamlessly integrated with BIM models, offers real-time visual insights into project execution for improved monitoring and control. M/s Open Space has been appointed on a trial basis, as per the memorandum dated 24.08.2023, to assess the system's feasibility and effectiveness in CPWD projects. The trial aims to inform decisions on potential broader implementation based on its performance and alignment with project requirements.

Application of BIM aims towards creation of real-time model of the project which subsequently may also be used for facility management. For such facility management, SOP need to be developed for hands on training of the concerned JE/ AE of the project. ADG Training may issue the necessary SOP for the training module identifying the checklist of component at the time of handover, detailing the utilization of COBie data matrix, Asset Identification and Management etc.

The application of BIM is directed at generating a real-time model of a project, which can later be utilized for efficient facility management. To facilitate this management process, Standard Operating Procedures (SOPs) need to be formulated for the hands-on training of the respective Junior Engineers (JE) and Assistant Engineers (AE) involved in the project. ADG Training is expected to issue the necessary SOPs for the training module, clearly outlining the checklist of components during handover, specifying the use of the COBie data matrix, and addressing aspects such as Asset Identification and Management.

C. Establishment Procedure

In the curriculum of foundation training of all the new entrants viz. Junior Engineer (Civil), Junior Engineer (Electrical), Assistant Executive Engineer (Civil), Assistant Executive Engineer (Electrical), Assistant Architect, Deputy Architect comprehensive BIM training should be included. Post completion of foundation training BIM shall be included in the syllabus of the examination.

Similar to engineering and accounts examination mandated for promotion / increment from one post to another, an independent paper should be prescribed for all the new entrants as well as mandatory provisions for the promotion / increment / MACP from JE / equivalent post to AE / equivalent post, AE / equivalent post to EE / equivalent post.

An attributes “knowledge of BIM” should be inserted in the APAR for Junior Engineer / Assistant Engineer / Executive Engineer and equivalent officers.

D. Empanelment of Architects/ consultants with BIM capabilities

The eligibility criteria for empanelment of architecture consultant should have mandatory provisions for BIM capabilities of the consultants. Already 49 architectural consultants have been empanelled wide OM number DG/Arch/80 Dated. 28.05.2020. Renewal / empanelment of the architectural consultants shall be done with mandatory provisions of BIM capabilities.

Wherever, CPWD is engaging architectural / structural / MEPF consultant a mandatory provision for BIM capabilities shall be incorporated in the RFPs / NITs / Bid documents.

A model mandatory provisions to be incorporated in the RFPs / NITs / Bid documents for empanelment / engagement of architectural / structural / MEPF consultant should be prepared and circulated by Chief Engineer (CSQ) Civil.

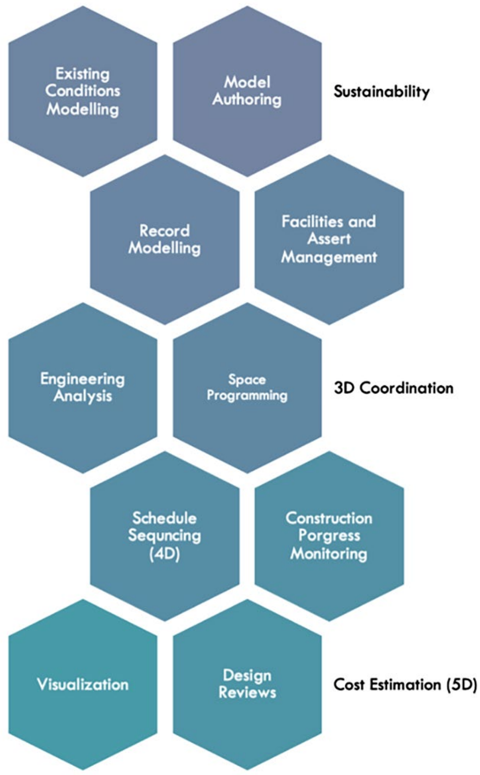
A provision for empanelment of BIM Auditors should be made so as to ensure that structural/ Building and site services; and geotechnical vetting for BIM models is done suitably as per the contract conditions. This should be strictly ensured otherwise if the model submitted by contractor is not as per standards, the entire exercise of BIM implementation will be futile.

E. Timeline

BIM based construction should be made mandatory with immediate effect for all the original works being executed through EPC mode, original works costing over Rs. 30 Cr. Being executed through other mode and all original works from January 1, 2025. BIM based asset maintenance work should be started effective from January 1, 2026.

BIM will serve as a crucial asset for CPWD, offering substantial benefits throughout the project life cycle. Through the utilization of advanced 3D Modelling, BIM will provide a dynamic and detailed approach for planning, design, construction, and operation, ensuring a reduction in on-site issues through simulation. The emphasis will go beyond mere clash detection and material quantification, extending to becoming a pivotal tool for decision support, project reviews, and quality assurance across all project phases.

As CPWD embraces BIM, the organization will streamline processes, elevate project outcomes, and uphold a high standard of excellence from project inception to ongoing maintenance. Apart from the above-mentioned objectives, specific applications of the BIM workflow have been identified by CPWD for its projects. All these applications have to be extracted and have been given below:



BIM Uses and Descriptions:

The key benefits of BIM are reduced delivery costs, green performance, predictable planning, reducing risks, reduced operational costs & increased quality and value. Additional benefits are high levels of collaboration, communication, and coordination among the stakeholders, consistent and coordinated designs and highly constructible design solutions (IBIMA 2016).

The method of applying BIM technology during PLC for achieving one or more specific objectives is termed as BIM Use. There are a varied number of tasks in the project lifecycle which can benefit from the incorporation of BIM technologies, and these benefits are documented as BIM Uses. These BIM Uses are identified from extensive literature review, comparison of BIM Uses in existing literature and further discussions with the BIM experts to finalize the list of BIM Uses. BIM Uses are organized in chronological order from strategic definition to the In-use stage of the RIBA (Royal Institute of British Architect) PLC stages that benefit the BIM implementation in AECO projects (Table 1). It is essential to consider the risk elements associated with implementing or not implementing a particular BIM Use. Some of the BIM Uses can significantly reduce overall project risk; however, they may shift risk from one party to another. In other situations, implementation of a BIM Use may potentially add risk for a party when they successfully perform their scope of work.

To deliver any BIM Use within the project execution process, it is essential to perform a set of BIM Uses. BIM Uses such as 2D documentation, 3D detailing, BIM/GIS overlapping, energy simulation, sustainability analysis and whole life cycle analysis can occur in six to seven stages of PLC. Few of these BIM Uses are fundamental for the delivery of BIM projects. The primary BIM Uses are design authoring, 2D documentation, clash detection, cost estimation, structural analysis, construction planning, BIM for facility management integration and many more. Moreover, for some of these BIM Uses to be executed, it is essential to have other sets of BIM Uses executed as a prerequisite. It is essential to realize the relationship between these BIM Uses which can be considered for future study.

The criticality of any particular BIM Use depends on the project type and its complexity. Some of the project types include green building (green), smart building (smart), complex façade or structure (facade) and many more. Each project type demands a different set of BIM Uses as critical ones. It is a prerequisite to understand the project type, project goals, and BIM Uses relationships to choose the right set of BIM Uses for any project delivery (IBIMA 2016).

Table 1. BIM Uses in Project Lifecycle

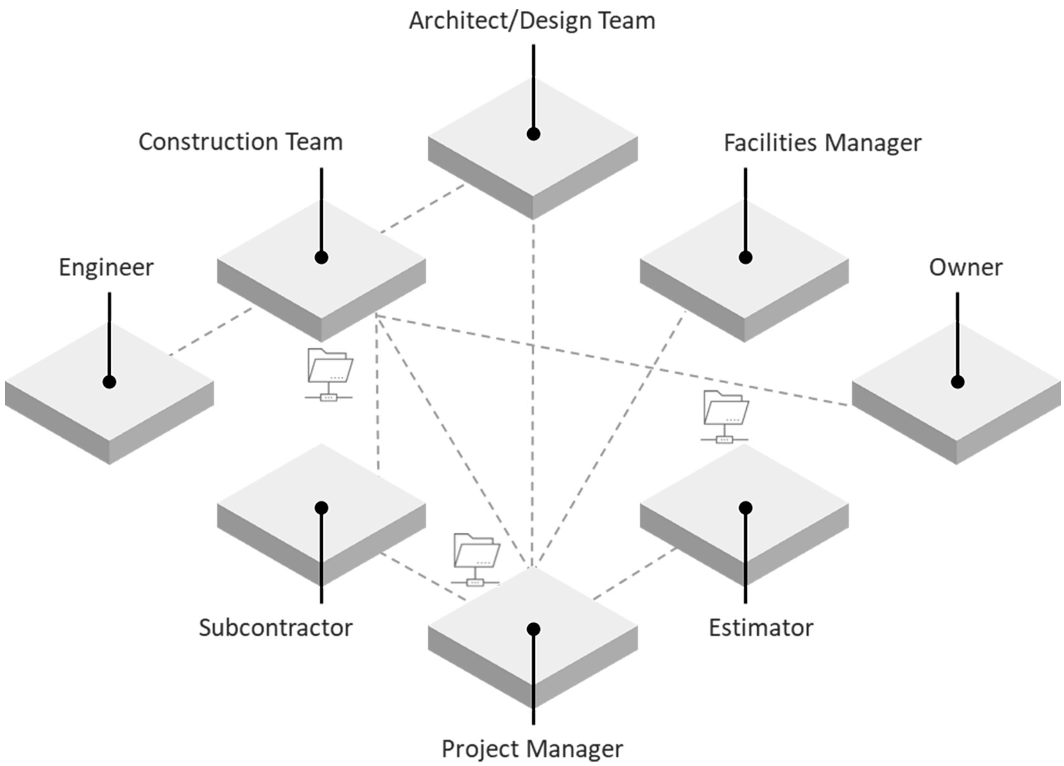
	BIM uses	Project type			Project life cycle stages							
S. No	X-axis: Life cycle stages / Y-axis: BIM Uses	Green	Smart	Façade	Stage 0 Strategic definition	Stage 1 Preparation & brief	Stage 2 Concept design	Stage 3 Developed design	Stage 4 Technical design	Stage 5 Construction	Stage 6 Handover & closeout	Stage 7 In Use
1	Site analysis											
2	Conceptualization											
3	Generative design											
4	Design authoring			***								
5	Space programming											
6	Visual Communication											
7	Virtual reality simulation											
8	Accessibility analysis											
9	2D Documentation											
10	3D Detailing			***								
11	3D printing			***								
12	Constructability analysis			***								
13	Clash detection											
14	Quantity take-off			***								
15	Cost estimation											
16	Acoustic analysis											
17	Electronic tendering											
18	Fire & smoke simulation											
19	Lighting analysis	***										
20	Reflectivity analysis	***										
21	Risk & Hazard Assessment											
22	Operations planning											

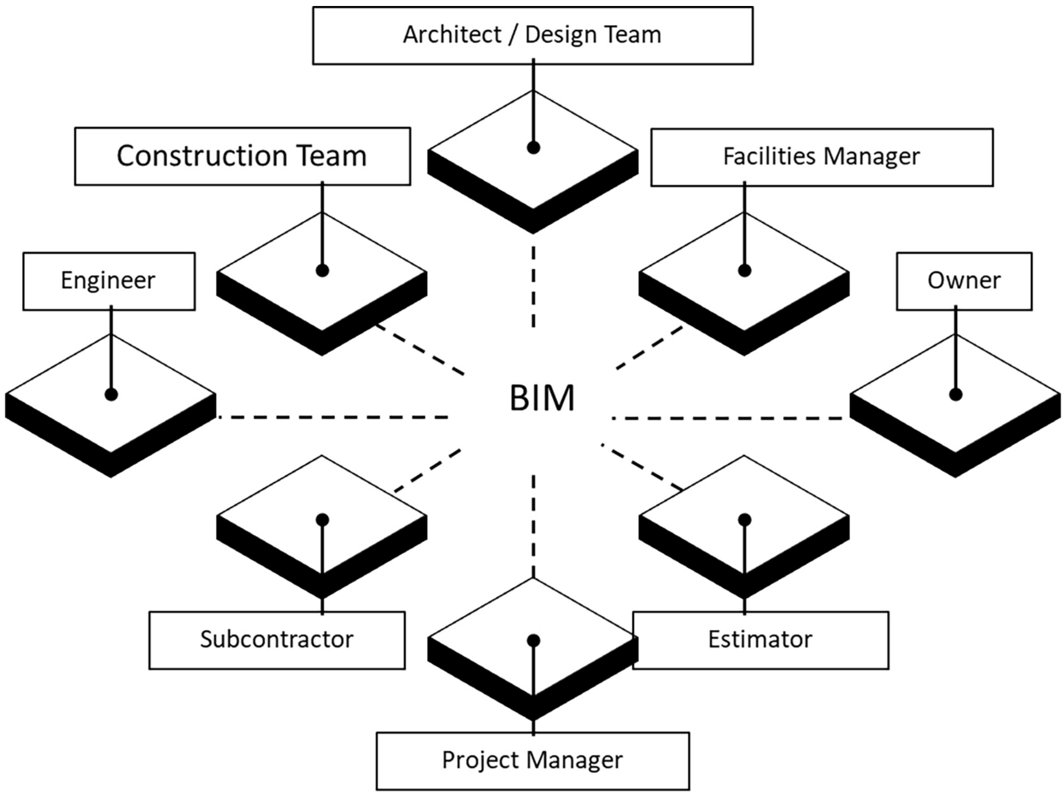
23	Solar analysis	***										
24	Wind studies	***										
25	Spatial analysis			***								
26	Finite Element Analysis											
27	Structural analysis											
28	Construction planning			***								
29	Surveying											
30	Lean process analysis	***										
31	BIM/GIS overlapping											
32	Urban planning											
33	Field BIM			***								
34	Selection & specification			***								
35	Safety analysis											
36	Construction Logistics			***								
37	Concrete Pre-casting			***								
38	Mechanical assemblies' prefab			***								
39	Code checking & validation	***										
40	Architectural modules prefab			***								
41	Casework prefabrication			***								
42	Sheet metal cutting			***								
43	Construction operation analysis											
44	Augmented reality simulation											
45	As-constructed representation											
45	Handover & Commissioning	***	***									
47	Energy use	***										
48	Sustainability Analysis	***										

49	Record keeping		***									
50	Building inspection											
51	BIM/FM integration		***									
52	Building automation		***									
53	Asset maintenance		***									
54	Relocation management											
55	Space management		***									
56	BIM/IOT interfacing		***									
57	BIM/web-services Extension		***									
58	BIM/Spec linking		***									
59	Real-time utilization		***									
60	Site set-outs											
61	Lift planning		***									
62	Asset tracking		***									
63	Performance monitoring	***										
64	BIM/PLM overlapping		***									
65	Asset procurement											
66	Value analysis											
67	Demolition planning											
68	Egress and Ingress											
69	Disaster planning											
70	Security analysis											
71	Thermal Analysis	***										
72	Whole life cycle analysis	***										
73	Laser scanning											
74	Photogrammetry											

CPWD BIM Workflow

In the CPWD BIM workflow, the integration of a systematic approach with an ERP collaboration system ensures a centralized platform for storing and accessing information for all stakeholders. Designated roles and responsibilities have been assigned to facilitate seamless information transfer and ensure consistent verification of the construction process in alignment with the model.





Traditional Process VS BIM

Stakeholders are encouraged to designate personnel responsible for addressing queries related to the BIM process, including coordination issues and site construction tracking procedures.

Key Personnel in BIM Process: Roles and Responsibilities

As already stated, each project is unique and there is no standard procedure for defining every parameter of the process. Even the roles and responsibilities of each there are several key personnel in the BIM Workflow and their roles are given below. However, the same may be amended as per the individual project requirements.

Project Owner/Client:

- Define project requirements and objectives.
- Approve BIM deliverables.
- Review and provide feedback on BIM models.
- Manage project budget and schedule.
- Ensure compliance with building codes and regulations.

Architect:

- Develop conceptual and detailed design models.
- Create construction documents and specifications.
- Coordinate with other design disciplines.
- Conduct design reviews and ensure design quality.
- Address design issues and respond to requests for information (RFIs).

Structural Engineer:

- Develop structural analysis and design models.
- Design structural components (e.g., beams, columns, slabs, foundations).
- Ensure structural integrity and compliance with building codes.
- Coordinate with architects and other engineers.
- Prepare structural shop drawings and specifications.
- Mechanical, Electrical, and Plumbing (MEP) Engineer:
- Design mechanical, electrical, and plumbing systems.
- Coordinate with architects and structural engineers.
- Prepare MEP shop drawings and specifications.
- Conduct energy modelling and analysis.
- Ensure compliance with building codes and regulations.

BIM Manager:

- Develop and implement the BIM execution plan (BEP).
- Coordinate BIM activities among project stakeholders.
- Train and support the project team on BIM software.
- Resolve BIM conflicts and issues.
- Manage BIM data and models.

BIM Coordinator:

- Assist the BIM manager in implementing the BEP.
- Coordinate BIM data exchange and collaboration.
- Conduct BIM quality checks and audits.
- Prepare BIM reports and documentation.
- Maintain BIM library and standards.
- Construction Contractor:
- Interpret BIM models and drawings for construction purposes.
- Develop construction plans and schedules.
- Coordinate with subcontractors and suppliers.
- Manage construction activities and resources.
- Ensure quality control and safety compliance.

BIM Facilitator:

- Facilitate communication and collaboration among project stakeholders.
- Organize BIM meetings, workshops, training, and support.
- Develop BIM standards and guidelines.

4. CPWD's BIM Implementation Framework:

Central Public Works Department (CPWD) is committed to adopting the most advanced Model Authoring and processing tools for the seamless implementation of Building Information Modelling across all its projects nationwide. A critical benchmark for evaluating the authoring platform revolves around the ease of information flow and interoperability with other pertinent platforms.

Authoring Platform Evaluation:

Objective: Identify and deploy the most effective Model Authoring and processing tools for BIM projects.

Assess the ease of information flow and interoperability with associated platforms. Data storage will be carried out in the CPWD ERP system, and an authoring tool will be required to develop 3D models for each discipline, i.e., Architecture, Structure, and MEP. In the AEC industry, the widely adopted authoring tool is Autodesk Revit, which supports all disciplines.

Key Criterion: Assess the ease of information flow and interoperability with associated platforms.

Information Exchanges (IE):

Definition: Information Exchanges involve the submission of data from an information authoring party to the receiving party, emphasizing information processing and interoperability.

Objective: Ensure that downstream processes receive data containing the requisite information for successful execution.

Collaborative Definition: Stakeholders responsible for BIM applications at each project stage work together to define information exchange procedures and data requirements. CPWD has established a collaboration platform in house, i.e., the ERP system, where collaboration, 4D, and 5D aspects are seamlessly managed.

Collaborative Process:

Procedure: Collaboratively define information exchange procedures and data requirements for each project stage.

Stakeholder Engagement: Active involvement of relevant stakeholders responsible for executing identified BIM uses.

Outcome: Identification of minimum content requirements for each resulting information exchange based on the collaborative efforts of stakeholders.

Information Flow and Model Sharing Procedures:

In order to facilitate seamless collaboration, data sharing, viewing, commenting, coordination, and communication for all projects, the Collaboration and Estimation tool of the ERP system will be employed. This tool serves as a central hub for project-related activities, ensuring effective engagement with stakeholders at various stages of project development.

Utilization of ERP Collaboration and Estimation Tool:

The ERP Collaboration and Estimation tool will be the primary platform for key project interactions, including data sharing, viewing, commenting, coordination, and communication. This ensures a centralized and efficient approach to manage project information.

Methodology for Stakeholder Understanding:

To provide stakeholders with a comprehensive understanding of project deliverables and the anticipated stages of deliverable completion, a clear methodology will be outlined. This will include a transparent presentation of project deliverables and their corresponding timelines.

Internal Communication via ERP:

The established method for internal communication among stakeholders is the ERP system. Standard Operating Procedures (SOP) for internal communication have been previously issued, ensuring consistency and clarity in information exchange.

Default Spaces and Stakeholder Access:

Default spaces within the collaboration system have been pre-established for each stakeholder, streamlining access to relevant project information. In the event of new members or consultants joining the project, dedicated spaces will be created for them, with access granted by the Project-in-charge.

Individual Workspaces and Coordination:

Stakeholders will be assigned individual workspaces within the collaboration tool, allowing them to work on the project model independently. Optionally, a separate space may be created for coordination purposes, or coordination activities can be conducted within the space of the Project-in-charge (PIC). This flexibility ensures efficient collaboration tailored to the needs of the project team.

In the BIM modelling strategy, the 3D BIM model serves a dual purpose: clash detection and coordination for identifying design issues. Any issues detected are communicated to respective consultants, and resolutions are updated in the model. Additionally, the model adheres to 4D and 5D BIM guidelines, ensuring its compatibility with downstream processes.

Transmission of data between various tools and formats is integral. Ensuring a seamless process requires the modelling team to take precautions, facilitating smooth data transfer without loss between different stages and applications.

Coordinate System Requirements:

A standardized three-dimensional (XYZ) coordinate system is mandated for all BIM data to ensure seamless model federation without the need for additional relocation or conversion activities during 3D coordination. The specified coordinate system, detailed in the project's BIM Execution Plan (BEP), includes information on the project datum, height datum, project location (latitude and longitude), and model positioning points such as Project Base Point and Survey Point.

Units and Measurement Consistency:

Consistent units and measurements across CPWD project files are crucial. The default project units are set to millimetres with two decimal places to maintain accuracy. Different drawing types, such as site layout drawings, adhere to specific unit and measurement protocols. The conversion between Imperial and Metric units is strictly prohibited to ensure consistent and conventional measurements.

5. Standards to maintain for adoption of 3D BIM Modelling

Architectural Standards:

Wall modelling includes considerations for construction elements, layer thickness, proper connections, and accurate representation of construction and expansion joints.

Columns are modelled with attention to structural and decorative aspects, accounting for material and layer thickness.

Floors, ceilings, and roofs are modelled separately with precise attributes such as finishes, thickness, and material.

Structural Standards:

Structural framing elements like beams and columns are modelled with consideration for their dimensions and locations.

Floors and foundations are modelled to represent construction and expansion joints accurately.

Mechanical, Electrical, and Plumbing (MEP) Standards:

MEP equipment, ducts, pipes, cable trays, lighting fixtures, and other elements are modelled based on manufacturer specifications and system requirements.

Special attention is given to clearance parameters, proper elevation settings, and accurate representation of plumbing systems.

Model Breakdown Strategy:

To ensure an efficient and workable model, a model breakdown strategy is implemented, combining linked files and work sets. The model is categorized into four main types:

Grids and Levels Model:

Limited to grids and levels, serving as a reference for the project's base point and extent.

All other models derive their grids and levels from this model.

Ghost Model:

Aggregates all DWG files for linking within Base Models to prevent data pollution.

Base Model:

Primary 3D modelling space divided into linked files based on project zones and corresponding levels.

XRef Model:

Created to consolidate multiple linked models, streamlining the linking process for specific disciplines.

Model Description Document (MDD):

Each model submission must include an MDD detailing its contents, major revisions, purpose, and limitations. This document provides clarity and context for model interpretation.

Permission and Access:

Model access is tailored based on stakeholders, disciplines, and changes. The Project In-Charge can provide access to various stake holders as per the need of project and involvement of various disciplines. Authority to modify the model and view the model will be governed by the Project In-Charge while adding the users in various spaces as per their role according to BEP.

Drawing Standards:

1. Basics:

Standardized paper size, scale, and drawing sheet templates.

Clear title block information and drawing status.

2. Annotations and Units:

Consistent annotation standards and uniform units.

Standardized dimensions, revisions, and holds.

3. File Management:

Organized file storage and naming conventions.

Proper layer naming and geo-referencing.

4. Project Specifics:

Adherence to project grid and drawing composition guidelines.

Proper handling of references (Xrefs).

Additional Standards:

Drawings contain design information relevant to their intended use.

Emphasis on minimum detailing for efficiency.

Logical organization of a minimal number of drawings.

Avoidance of view duplication to maintain drawing integrity during design iterations.

Design to Fabrication Workflow:

In navigating a seamless journey from design to fabrication, a key consideration lies in discerning the boundaries of Modelling and strategically incorporating detailing. This strategic approach aims to maximize project benefits while minimizing drafting efforts.

Detail Level Balance:

Striking the right balance is crucial. Insufficient detail hampers usability, while excessive detail burdens efficiency.

BIM Execution Plan Guideline:

Clearly defined in the Project BIM Execution Plan is the transition point from 3D geometry to 2D detailing, ensuring a well-planned progression.

Intelligent 2D Linework:

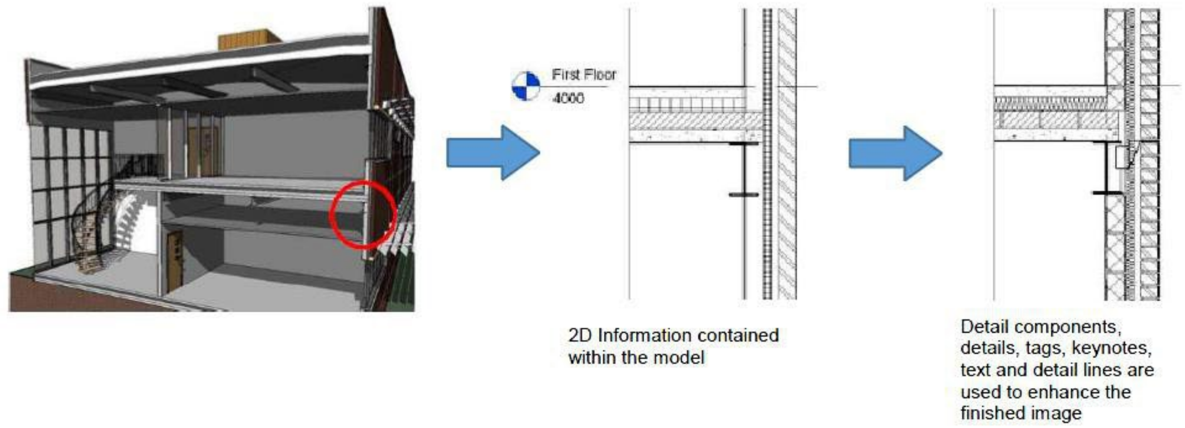
Elevating views, intelligent 2D linework is integrated to complement geometry, adding richness without taxing hardware. Its application extends beyond detailed and fabrication-focused elements.

Detailing Excellence:

Employing detailing and enhancement techniques becomes imperative. This preserves model integrity while simplifying complexity where feasible.

Precision in 3D Modelling:

The core of the workflow involves 3D modelling at a meticulous 1:50 accuracy. Additional details are judiciously layered over time, contributing to a comprehensive and refined outcome.



Text Standards and Annotation Guidelines:

Text Style:

In the absence of predefined text standards, utilize Arial Narrow with the font file Arialn.ttf.

Consistent Appearance:

Ensure uniformity in text appearance throughout the drawing set.

Legibility and Clarity:

Annotations must be legible, clear, and concise, even when drawings are plotted at reduced sizes.

Arrowhead Style:

Opt for dot-style arrowheads over closed filled arrowheads for calling up hatched/shaded areas.

Avoiding Overlaps:

Prevent text overlap with critical model components, prioritizing the legibility of both annotations and drawings.

View Templates for Standardization:

Maximize the use of View Templates to enhance standardization, minimizing Manual effort and reducing errors.

Dimensioning

Although all the dimensioning standards cannot be defined at the initial stage of the project and will evolve slowly through the execution. There are certain standards which should be ensured and provide a standardization to the dimensioning from which the generation has to be started. Default dimension styles should be provided for the consistent appearance of dimensions across all project documentation. Following are a few standards that has to be followed in projects undertaken by CPWD, but not limited to.

- Where practical, all dimensioning shall be created using relevant software dimensioning tools. The dimension text shall not be exploded or overridden, but can be appended, e.g. "1200 (Typ.)".
- Where practical avoid duplicate dimensioning either within a drawing or within a set of drawings.
- Where practical, dimension lines shall not be broken and shall not cross other dimension lines.
- In general, dimensions shall be placed on a drawing so they may be read from the bottom or right-hand side of the drawing.
- In general, dimension text shall be placed above the dimension line and shall be clear of other lines so that they are legible.
- In general, dimension styles shall adopt standard engineering style dimensioning using:
- Closed filled 3:1 / 20° arrow head for unconfirmed dimensions
- 45° diagonal tick/slash for confirmed dimensions
- Default dimension styles shall not be overridden.
- Effort should be made that the dimensions are legible and minimum overlapping with the model components are seen, before finalizing the drawing.

Clash Detection & Coordination Process:

Efficient clash detection and coordination are pivotal advantages of the BIM process. Each discipline is accountable for internal and cross-discipline model coordination, resolving major issues before federating models and initiating clash detection.

The process entails initial clash detection using IFC inputs in the first BIM model deliverable. Regular clash runs are conducted before significant design milestones and at fixed intervals for utilities. A Comprehensive Clash Detection report is prepared, documenting the clash detection strategy. This report includes clash results communicated to the project team, along with comments, screenshots, and annotated drawings.

The project team collaboratively addresses conflicts, leading to model updates and verification of clash resolutions. The Clash Detection Matrix serves as a key tool for effective project coordination.

Reporting involves sharing the first Comprehensive Clash Detection report after completing Architectural, Structural, MEPF, and Interiors Models. Post-conflict resolution, a coordination model is generated.

As described, the first level clash detection would happen through the IFC inputs and the aim would be to coordinate all the disciplines and provide an integrated model from the IFC inputs.

Process

After the model is coordinated, regular design coordination meeting every 7 days would ensure that there are no new clashes in the model due to any new inputs.

In order to ensure the BIMs are coordinated properly the project team disciplines will perform clash detection against each other's models. This will minimize and hopefully eliminate the risk of uncoordinated information reaching site provided the team adhere to the proposed process. It will also help to highlight and resolve problems that are overlooked in the day-to-day coordination of models.

Clash detection can be a time-consuming process, especially if one tries to eliminate every possible clash so it is important to set up rules relating to the process. It is also imperative that each discipline coordinates their design with respect to other disciplines and elements are drawn in the correct 3D space to avoid unnecessary clashing and re-modelling work.

Clash detection will therefore be performed for all major building elements using appropriate software.

Clash Detection Categories:

Three categories—hard, self, and clearance—define clash detection. 'Hard' checks involve geometries between disciplines, 'clearance' checks address soft clashes when specific elements aren't modelled, and 'self' checks focus on single disciplines during Construction Documentation to avoid duplication.

Strategy:

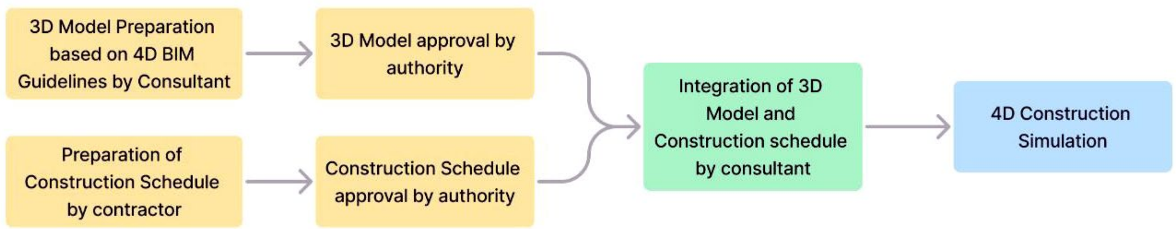
A shared understanding of genuine clashes needing resolution is crucial. Models from different trades are merged for coordinated identification and resolution of issues in a virtual environment, minimizing on-site and construction-related costs.

Model Accuracy & Tolerance:

Models are drawn at 1:1 scale with consistent units and measurements across disciplines, aligning with project standards. Clash detection setup tolerances range from zero to a maximum of 5mm, detailed in the Appendices with Subcontractor completion.

Resolution Process:

After initial IFC input coordination, clash detection runs periodically with new inputs. Weekly coordination meetings address and resolve issues, repeating the process to ensure a clash-free model at each stage.



6. CPWD's Future Approach to 4D Modelling Standards:

CPWD will follow straightforward rules in creating digital models. Each part, like walls or windows, will be kept separate and easy to understand. It will be akin to building with digital blocks. The team will ensure that every detail, no matter how small, has a name and material. It will be a bit like organizing a digital puzzle. The model will be divided into different sections, making everything clear and tidy. If something isn't needed, it will be removed to keep things neat. This way, the digital construction will resemble a well-organized Lego set, ensuring everything fits together just right.

Model Property list

3D Properties Name	Description / Example
ID	Object id
Object Type	Piles, Pile cap, Pier, Segment, Slab, Wall, foundation etc.
Level	Helps to identify individual component such as Embankment Top, Subgrade top, GSB Top, DLC Top, PQC Top etc.
Chainage	101.135 to 101.635
Package	Package l, Package 2, Package 3 etc.
Volume	Volume in m3
Surface Area	Top Surface Area of layers as specified in drawings or as calculated by the modeler.
Thickness	Thickness of layer as specified in drawings
Length	Length of layer as specified in drawings
Material Name	M35 Precast concrete, M 50 cast-in situ etc.
Material ID	Material ID shall describe brief specification of material name.
Family Name	Family name should be identifiable Ex: Dry Lean Concrete

Model Quality Assurance Protocols

The Project Lead, Coordinators, and BIM modelers are the quality team in charge of BIM processes. They ensure models align with design inputs through continuous checks. Specific measures in the 3D BIM models, detailed in a table below, cover quality control, accuracy, and tolerances. Regular visual checks, integrity assessments, and BIM standards audits are standard practices for maintaining quality.

Quality Control Measures for BIM Models

Check	Definition	Project Stage	Frequency
Visual check	See that there are no unintended model components and the design intent has been followed and design comprehends to the design inputs.	Detailed Design	Ongoing
Interference check	Detect problems in the disciplines model where two components are clashing including soft and hard. Also, verify clash free model whenever any new design inputs are received.	Detailed Design	Fortnightly, prior to information exchange

Model integrity checks	Ensure integrity of the model aligns with BIM Uses and client's BIM specific modelling and documentation requirements and standards, as set out in Model Standards.	Detailed Design	Fortnightly
Design review	Review that the ongoing development of the model is aligned with the client objectives.	Detailed Design/ Execution	Monthly

Time Management (4D)

The 4th dimension refers to adding time to the 3D, often called 4D modelling or model-based scheduling. This is done by linking objects from the 3D model, to a task in the construction schedule, using a 4D scheduling tool like Vico Office, Synchro or Navisworks. As part of ERP, Collaboration, Estimation and Scheduling Tool should be utilised for Time management. This approach is changing how complex projects are planned, making it possible to visualize the whole construction project or just some phases of it, and see who timing of tasks affect the workflow. This includes comparison of planned versus actual schedules; time-based clashes, such as verifying the planned sequence towards constrained activities (i.e. demolition, permanent construction and temporary construction), site utilization planning and more.

A 4D model can be used at all stages of the project. During the conceptual design, it can be used to discuss site logistics. During the construction phase it can be used to validate costs of completed work, demonstrate work to owners, provide health and safety instructions and justify subcontractor billings to the owner for completed work. Once a 4D schedule is setup, it requires little work to maintain and update.

The fourth dimension, also known as model-based scheduling or 4D modelling, is the addition of time to the 3D. This is accomplished by utilizing a 4D scheduling program such as Vico Office, Synchro, or Navisworks to link elements from the 3D model to a task in the building schedule. Time management should be facilitated by the use of collaboration, estimation, and scheduling tools included in ERP. This method is altering the way complicated projects are scheduled, enabling the visualization of the entire construction project or just specific phases, and determining how the sequencing of tasks impacts the overall workflow. This covers a range of topics, such as comparing the planned and actual schedules, resolving time-based conflicts, confirming the intended order for operations with constraints (such as demolition, permanent construction, and temporary construction), and organizing the use of the site.

At any point during the project, a 4D model can be utilized. Site logistics can be discussed using it throughout the conceptual design phase. It can be used to verify completed work prices, show owners what has been done, give health and safety guidelines, and support subcontractor billings to the owner for finished work during the building phase. A 4D timetable is easy to maintain and update once it is set up.

Cost Estimation 5D

5D modelling or model-based estimating is the 4D model in addition to cost information. A model-based schedule or 4D schedule is associated with information on cost, which allows the owner to know the exact amount the contractor should be billing at a given time. Over the past years the method has been redefined, where the 5D estimations is done in the form of a take-off, where the model is used to extract quantities of materials and associate costs with those materials for estimating purposes.

Facility of Take off for different material is available in the Collaboration platform where all the relevant DSR items have been made part of the Information System.

It should be noted that the model cannot provide accurate estimates until LOD has been properly defined. Experienced personnel in both technology and in cost estimation are required to achieve success in applying the 5th dimension.

Collaboration and Estimation Tool of ERP is a unique customised application for collaboration of all stakeholders along with quantity take-off and scheduling capabilities.

Facility Management Integration: (6D)

The primary objective of implementing BIM for CPWD projects is effective Operations and Maintenance. A streamlined process gathers information through material submittals and specifications, embedding it into the BIM model as custom parameters. ERP Platform has the provision of creating and maintain the asset register. With the use of BIM model, the asset register of ERP can be further enhanced with an information rich model.

The project will have to divided into specific areas and zones for better asset identification and management. Extracted parameters form asset registers, such as COBie sheets, aiding CPWD's Facility Management.

7D BIM

Integrating 7D BIM into CPWD's projects will enhance sustainability by adding crucial data on environmental impact and resource efficiency. This addition, with carefully defined parameters, will ensure informed decision-making and align projects with eco-friendly practices.

Simultaneously, the adoption of 8D BIM in CPWD's upcoming projects will improve project safety by integrating health and safety information. This includes detailed risk assessments, safety measures, and well-being considerations. Defining specific information parameters will be key to ensuring a safer working environment, reducing risks, and ensuring compliance with health and safety standards. CPWD's adoption of 8D BIM will contribute to the overall success and sustainability of their projects.

Asset Register Creation:

Asset registers assist in Facilities Management processes, creating a structured asset database for operation and maintenance. These registers help in specialist subcontractor contracts, spare parts determination, and maintenance planning. The BIM model generates an initial Excel sheet for asset registers, modified and maintained by the client FM team. It supports planned and reactive maintenance, human resource strategy, cost monitoring, and asset renewal.

Asset Register Template:

Deciding parameters for BIM models and extracting them for asset registers is crucial. The template includes Asset Code, Asset Description, Drawing Reference, Sub-Assets, Quantity, Contractor/Subcontractor, Asset Location, Manufacturer Details, and DLP. Information is progressively embedded in the model, focusing on essential components. Zone and level divisions define each asset's location.

Asset Code Structure:

The Asset Code is a unique identifier for each asset, ensuring accurate history throughout the project's life cycle. The code structure is organized, providing maximum information. Each asset code is unique, preventing reuse to maintain accuracy in asset history.

7. Digital Twin

Digital twin is a term that refers to the digital representation of a physical object, system, or process. It is a way of creating a virtual model that mirrors the real-world counterpart in terms of structure, behaviour, and performance. Digital twin technology enables the simulation, analysis, and optimization of complex systems and processes, as well as the integration of data from multiple sources, such as sensors, IoT devices, and cloud services.

Digital twin technology has many benefits for various industries and domains, such as manufacturing, construction, architecture, engineering, and design. It can help improve product quality, reduce costs, enhance efficiency, accelerate innovation, and support sustainability. Some of the applications of digital twin technology include product development, lifecycle management, predictive maintenance, asset management, and smart cities.

Nowadays, various companies have brought in various innovations and are offering ground breaking options in the field of digital twin technology and are offering a range of solutions and services that helps to create, manage, and use digital twins such as, Autodesk, Aveva, Dassault System etc.

Digital Twin Concept and Benefits

Digital Twin was popularized by NASA in the 2000s, when it used digital twins to monitor and control spacecraft and rovers. NASA's digital twins were able to simulate the physical and operational conditions of the space vehicles, as well as the interactions with the environment and the human operators. NASA's digital twins helped to ensure the safety, reliability, and performance of the space missions, as well as to troubleshoot and resolve issues remotely.

Digital twin technology has many benefits for different stakeholders, such as product developers, manufacturers, operators, and end-users. Some of the benefits are:

Improved product quality: Digital twin technology can help to design and test products in a virtual environment, reducing the need for physical prototypes and experiments. This can help to improve the accuracy, reliability, and functionality of the products, as well as to identify and eliminate defects and errors early in the development process.

Reduced costs: Digital twin technology can help to optimize the use of resources, such as materials, energy, and time, in the production and operation of products. This can help to reduce the costs of manufacturing, maintenance, and repair, as well as to extend the lifespan and value of the products.

Enhanced efficiency: Digital twin technology can help to streamline and automate the workflows and processes involved in the creation and management of products. This can help to increase the productivity, speed, and flexibility of the product lifecycle, as well as to reduce the risks and uncertainties.

Accelerated innovation: Digital twin technology can help to foster creativity and collaboration among the product stakeholders, such as designers, engineers, and customers. This can help to generate new ideas, solutions, and features for the products, as well as to customize and personalize the products according to the customer needs and preferences.

Supported sustainability: Digital twin technology can help to monitor and improve the environmental and social impacts of the products, such as the carbon footprint, energy consumption, and waste generation. This can help to enhance the sustainability and circularity of the products, as well as to comply with the regulatory and ethical standards.

Digital Twin Applications

Digital twin technology has many applications in various industries and domains, such as manufacturing, construction, architecture, engineering, and design. Some of the examples of digital twin applications are:

Product development: Digital twin technology can help to create and test products in a virtual environment, using 3D modelling, simulation, and analysis tools. This can help to improve the design and performance of the products, as well as to reduce the time and cost of development. For instance, digital twin technology can help to design and optimize the aerodynamics, fuel efficiency, and safety of a car, or the functionality, durability, and aesthetics of a smartphone.

Lifecycle management: Digital twin technology can help to manage and optimize the entire lifecycle of a product, from conception to disposal, using data from sensors, IoT devices, and cloud services. This can help to monitor and control the product's condition, performance, and usage, as well as to predict and prevent failures, anomalies, and risks. For example, digital twin technology can help to track and optimize the maintenance, repair, and operation of a jet engine, or the energy consumption, comfort, and security of a smart home.

Predictive maintenance: Digital twin technology can help to anticipate and prevent the breakdowns and malfunctions of a product, using data analytics, machine learning, and artificial intelligence. This can help to improve the reliability and availability of the product, as well as to reduce the downtime and cost of maintenance. For instance, digital twin technology can help to detect and diagnose the faults and errors of a wind turbine, or the wear and tear of a conveyor belt.

Asset management: Digital twin technology can help to optimize the utilization and value of a product, using data visualization, optimization, and decision support tools. This can help to improve the efficiency and profitability of the product, as well as to enhance the customer satisfaction and loyalty. For example, digital twin technology can help to manage and allocate the inventory, capacity, and demand of a warehouse, or the traffic, parking, and mobility of a smart city.

Smart cities: Digital twin technology can help to create and manage smart cities, using data from sensors, IoT devices, and cloud services. This can help to improve the quality of life, safety, and resilience of the city, as well as to support the urban planning and development. For example, digital twin technology can help to monitor and optimize the energy, water, and waste management of a city, or the health, education, and social services of a city.

8. Extended Reality: A New Way of Design Review and Collaboration

Extended reality (XR), encompassing augmented reality (AR), virtual reality (VR), and mixed reality (MR), is transforming the construction industry by offering a full spectrum of immersive experiences. From modelling and design to execution and maintenance, XR provides a dynamic platform for visualizing, planning, and implementing construction projects.

Workshop XR by Autodesk, Wild, Prospect, etc. for example, is an immersive design review workspace specifically designed for Architecture, Engineering, and Construction (AEC) teams. It allows project teams to naturally inspect and scrutinize 3D models, and problem-solve together in real-time. This technology promotes collaboration and enhances understanding among project members, leading to more efficient and effective construction processes.

One concrete example of how Workshop XR is used in the construction industry is its application in collaborative project execution. For instance, during a workshop on the SKETS campus, Autodesk introduced Workshop XR as a groundbreaking XR-based technology. This platform, demonstrated remarkable efficacy in collaborative project execution, empowering architects, designers, and engineers to explore, automate, and review construction projects.

What problems does Extended reality help to address?

The AEC industry faces many challenges in the design and construction process, such as complex workflows, misalignment, design issues, rework costs, and remote collaboration challenges. XR aims to solve these problems by providing a platform that enables:

Complex workflows and misalignment: XR simplifies the workflows and aligns the project team. This allows for easy access to the latest files, issues, and team members.

Design issues and rework costs: XR helps to identify and resolve design issues early in the process by allowing the project team to inspect and scrutinize 3D models in a realistic and immersive environment. XR also enables quality control and planning by creating training scenarios that help operators prepare for maintenance and operations. This reduces the risk of errors and rework costs. With XR, you can improve the design quality and efficiency and avoid costly mistakes and delays.

Remote collaboration challenges: XR facilitates remote collaboration by allowing the project team to join the same immersive workspace from anywhere in the world.

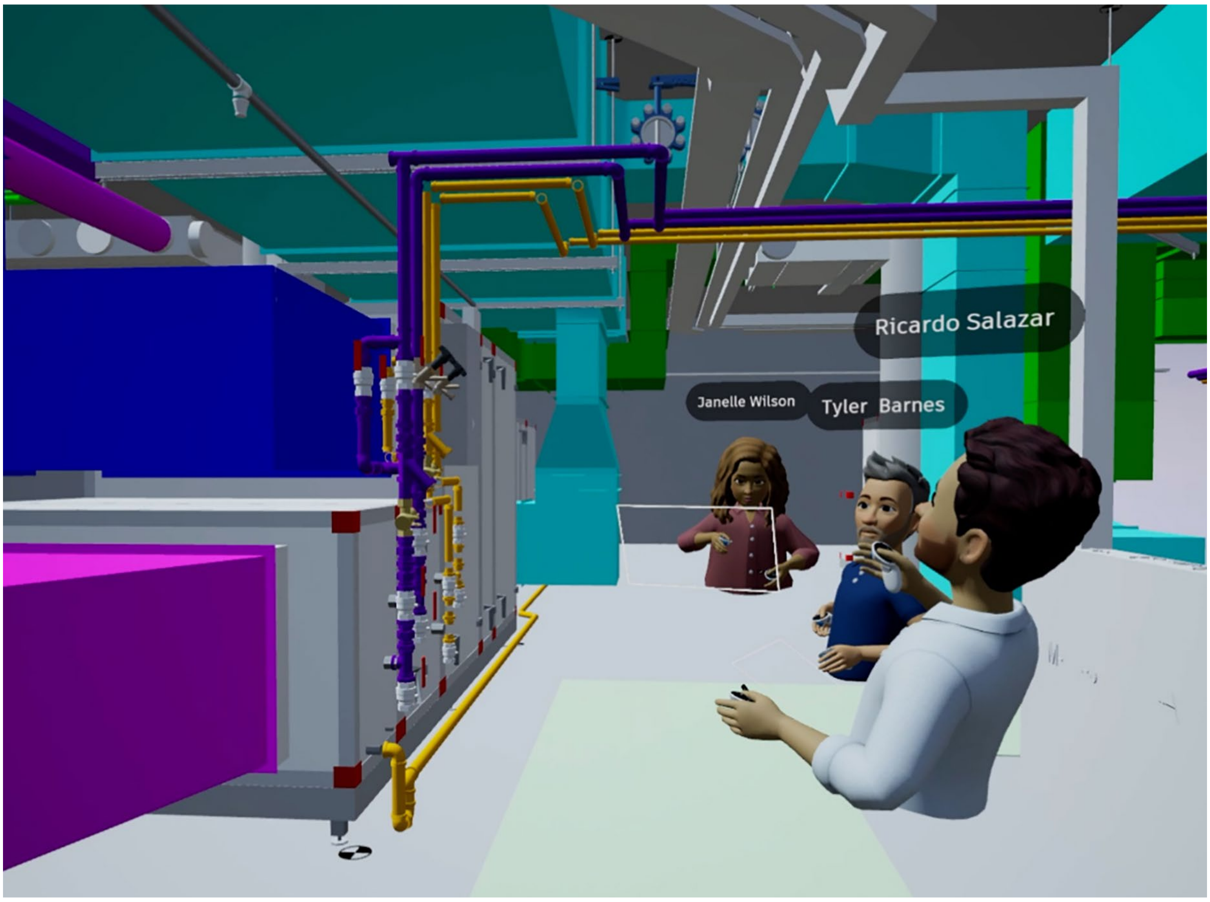
What are the benefits of XR?

XR offers many benefits for the AEC industry, such as:

Improved design quality and efficiency: XR allows the project team to review and validate design decisions in a realistic and immersive environment. XR also helps to detect and resolve design issues early in the process, reducing the need for rework and delays. XR also provides feedback and insights that can help the project team optimize the design and performance of the project. With XR, you can achieve better design outcomes and save time and money.

Enhanced collaboration and communication: XR enables the project team to collaborate and communicate effectively in a dynamic and interactive workspace

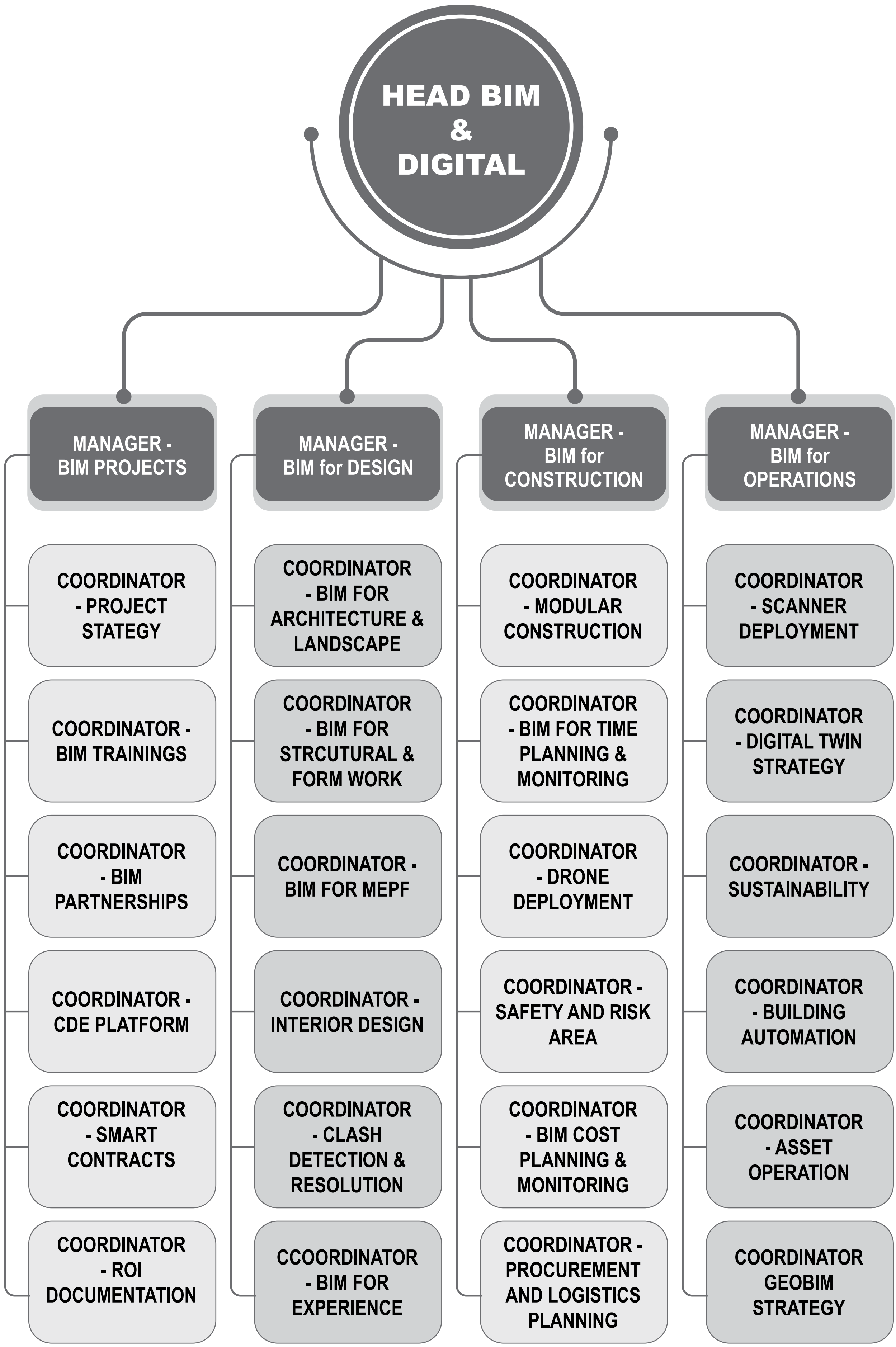
Reduced costs and risks: XR helps to reduce costs and risks by minimizing errors and rework, improving quality control and planning, and creating training scenarios. XR also reduces the need for physical mock-ups and site visits, which can be expensive and time-consuming. With XR, you can reduce the costs and risks associated with the design and construction process and increase the return on investment.



9. BIM Roles and their Responsibilities

Various BIM roles as globally experienced with BIM for better and smooth functioning of any organisation, who have implemented BIM to give most qualitative and productive output are mentioned here.

1. Head - BIM & Digital
2. Manager/ Lead - BIM (Project Strategy)
3. Manager/ Lead - BIM (Design)
4. Manager/ Lead - BIM (Construction)
5. Manager/ Lead - BIM (Operations)
6. Coordinator - BIM - Project Strategy
7. Coordinator - BIM - CDE Strategy
8. Coordinator - BIM - Smart Contracts
9. Coordinator - BIM – Partnership Strategy
10. Coordinator - BIM - ROI Documentation
11. Coordinator - BIM – Training Strategy
12. Coordinator - BIM - Architecture & Landscape
13. Coordinator - BIM - Structural & Formwork
14. Coordinator - BIM - MEPF
15. Coordinator - BIM - Clash Detection & Resolution
16. Coordinator - BIM - Interior Design
17. Coordinator - BIM - Experience Centre
18. Coordinator - BIM - Time Planning & Monitoring
19. Coordinator - BIM - Cost Planning & Monitoring
20. Coordinator - BIM – Hybrid Detailing
21. Coordinator - BIM - Procurement & Logistics Planning
22. Coordinator - BIM - Reality Capture
23. Coordinator - BIM - Safety & Risk Area
24. Coordinator - BIM - Digital Twin Strategy
25. Coordinator - BIM – Sustainability
26. Coordinator - BIM - Building Automation
27. Coordinator - BIM - Asset Operation
28. Coordinator - BIM - Scanner Deployment
29. Coordinator - BIM – GeoBIM Strategy


HEAD BIM & DIGITAL
MANAGER - BIM PROJECTS
MANAGER - BIM for DESIGN
MANAGER - BIM for CONSTRUCTION
MANAGER - BIM for OPERATIONS
COORDINATOR - PROJECT STATEGY
COORDINATOR - BIM TRAININGS
COORDINATOR - BIM PARTNERSHIPS
COORDINATOR - CDE PLATFORM
COORDINATOR - SMART CONTRACTS
COORDINATOR - ROI DOCUMENTATION
COORDINATOR - BIM FOR ARCHITECTURE & LANDSCAPE
COORDINATOR - BIM FOR STRCUTURAL & FORM WORK
COORDINATOR - BIM FOR MEPF
COORDINATOR - INTERIOR DESIGN
COORDINATOR - CLASH DETECTION & RESOLUTION
CCOORDINATOR - BIM FOR EXPERIENCE
COORDINATOR - MODULAR CONSTRUCTION
COORDINATOR - BIM FOR TIME PLANNING & MONITORING
COORDINATOR - DRONE DEPLOYMENT
COORDINATOR - SAFETY AND RISK AREA
COORDINATOR - BIM COST PLANNING & MONITORING
COORDINATOR - PROCUREMENT AND LOGISTICS PLANNING
COORDINATOR - SCANNER DEPLOYMENT
COORDINATOR - DIGITAL TWIN STRATEGY
COORDINATOR - SUSTAINABILITY
COORDINATOR - BUILDING AUTOMATION
COORDINATOR - ASSET OPERATION
COORDINATOR GEOBIM STRATEGY

The jobwise detailed roles are:

1. Head – BIM & Digital.

The Head for BIM & Digital Strategy for CPWD can be a Special Director General Level Officer who reports to the Director General CPWD. The Head of BIM & Digital role involves leading and overseeing the implementation of Building Information Modelling (BIM) and digital strategies across all phases of large-scale projects. This position is critical for ensuring that the organization adheres to industry standards and IS Codes while driving innovation and efficiency in project execution. His key responsibilities are :- Key Responsibilities

➔ Leadership and Management:

- Provide visionary leadership and strategic direction for the BIM & Digital team.
- Build and manage a high-performing team that fosters innovation and excellence.

➔ BIM Strategy Development:

- Develop and implement comprehensive BIM strategies that align with the organization's goals and project objectives.
- Ensure BIM practices are integrated into the project lifecycle, from concept to completion.

➔ Digital Transformation:

- Lead the organization's digital transformation efforts, incorporating the latest technologies to improve efficiency and quality.
- Drive the adoption of digital tools and platforms to enhance project delivery and stakeholder engagement.

➔ Standards and Compliance:

- Establish and maintain BIM standards and best practices in line with IS Codes.
- Ensure compliance with legal, regulatory, and contractual requirements.

➔ Interdisciplinary Coordination:

- Facilitate seamless collaboration between architectural, engineering, and construction disciplines.
- Oversee interdisciplinary coordination to achieve integrated project delivery.

➔ Design and Construction Optimization:

- Collaborate with project teams to optimize design and construction processes using BIM.
- Promote value engineering and innovative solutions to enhance project outcomes.

➔ Visualization and Communication:

- Coordinate the creation of high-quality visualizations and presentations to effectively communicate design concepts.
- Engage stakeholders with compelling narratives and data-driven insights.

➔ Training and Development:

- Implement training programs to enhance the skills and knowledge of BIM professionals within the organization.
- Foster a culture of continuous learning and professional development.

➔ Stakeholder Engagement:

- Build strong relationships with internal and external stakeholders, including clients, contractors, and government agencies.
- Represent the organization in industry forums and events.

➔ Innovation and Continuous Improvement:

- Stay abreast of emerging trends, technologies, and best practices in BIM and digital construction.
- Lead initiatives for continuous improvement and innovation in project delivery.

2. Manager/Lead – BIM for Projects.

Enabling end to end BIM and Digital Implementation for projects, medium to large scale with strict adherence to cost, quality and safety standards.

a. BIM Leadership: Provide leadership and guidance to the BIM team, ensuring adherence to BIM standards and best practices.

b. BIM Standards Development: Develop and maintain BIM standards, protocols, and procedures in alignment with industry standards and project requirements.

c. BIM Implementation: Oversee the implementation of BIM processes and technologies on projects, collaborating with project teams to ensure successful integration.

d. Model Management: Manage the creation, organization, and maintenance of BIM models throughout the project lifecycle, ensuring accuracy and consistency.

e. Quality Control: Conduct regular quality control checks on BIM models to ensure compliance with standards and project requirements.

f. Training and Support: Provide training and support to project teams on BIM tools, workflows, and best practices.

g. Coordination and Collaboration: Facilitate interdisciplinary coordination and collaboration using BIM, promoting integrated project delivery.

h. BIM Software Management: Evaluate, implement, and manage BIM software tools and technologies to support project requirements.

i. Documentation and Reporting: Maintain comprehensive documentation and reporting on BIM processes, standards, and project-specific workflows.

j. Emerging Trends: Stay informed about industry trends, emerging technologies, and best practices related to BIM, and implement relevant advancements into our processes.

3. Manager/ Lead – BIM for Design

Enabling end to end BIM and Digital Implementation for design phase of projects, medium to large scale with strict adherence to BIM Standards such as IS Codes.

a. Design Leadership: Provide design-focused leadership and guidance to the BIM team, fostering a culture of innovation and excellence in design.

b. BIM Strategy: Develop and implement BIM strategies tailored to the design phase of projects, aligning with project goals and design objectives.

c. Design Optimization: Collaborate with design teams to optimize design workflows and processes using BIM tools and technologies, enhancing design efficiency and quality.

d. Visualization and Presentation: Coordinate for compelling visualizations and presentations using BIM models to communicate design concepts and ideas effectively.

e. Interdisciplinary Coordination: Facilitate interdisciplinary coordination and collaboration during the design phase, ensuring seamless integration of architectural, structural, and MEP systems.

f. Design Reviews: Conduct design reviews and analysis using BIM models to identify design issues, opportunities for optimization, and value engineering solutions.

g. BIM Standards Development: Develop and maintain BIM standards and best practices specific to the design phase, ensuring consistency and quality across projects.

h. Training and Support: Provide training and support to design teams on BIM tools, workflows, and best practices, fostering a culture of continuous learning and improvement.

i. Stay Current: Stay abreast of emerging trends, technologies, and best practices in design and BIM, and incorporate relevant advancements into our design processes.

4. Manager/ Lead – BIM for Construction.

Enabling end to end BIM and Digital Implementation for construction phase of projects, medium to large scale with strict adherence to BIM Standards such as IS Codes.

a. Construction Leadership: Provide construction-focused leadership and guidance to the BIM team, ensuring alignment with project goals and construction objectives.

b. BIM Strategy: Develop and implement BIM strategies tailored to the construction phase of projects, optimizing construction workflows and processes.

c. Construction Sequencing: Utilize BIM models to develop and visualize construction sequences, phasing plans, and logistics strategies, enhancing construction planning and coordination.

d. Clash Detection and Coordination: Conduct clash detection analysis and coordination meetings using BIM models to identify and resolve conflicts, minimizing construction rework and delays.

e. Quantity Take-off and Estimating: Use BIM models for accurate quantity take-off and estimating, facilitating cost analysis, and budgeting during the construction phase.

f. Construction Documentation: Manage the creation and maintenance of construction documentation (e.g., 4D construction schedules, construction drawings) using BIM software tools.

g. Field BIM Implementation: Implement field BIM technologies and workflows to support construction activities, including field verification, progress tracking, and quality control.

h. VDC Simulations: Developing BIM simulations for procurement and logistics planning, safety and risk simulation.

i. Interdisciplinary Collaboration: Facilitate interdisciplinary coordination and collaboration during the construction phase, ensuring seamless integration of architectural, structural, and MEP systems.

j. BIM Standards Development: Develop and maintain BIM standards and best practices specific to the construction phase, ensuring consistency and quality across projects.

k. Training and Support: Provide training and support to construction teams on BIM tools, workflows, and best practices, promoting adoption and proficiency across the organization.

5. Manager/ Lead – BIM for Operations.

Enabling end to end BIM and Digital Implementation for operation phase of projects, medium to large scale with strict adherence to BIM Standards such as IS Codes.

a. Operations Leadership: Provide operations-focused leadership and guidance to the BIM team, aligning with the goals and objectives of our facility management program.

b. BIM Strategy: Develop and implement BIM strategies tailored to facility operations, optimizing workflows and processes for maintenance, asset management, and space planning.

c. Asset Information Management: Manage the creation, organization, and maintenance of asset information within BIM models, ensuring accuracy and accessibility for facility management activities.

d. Maintenance Planning and Scheduling: Use BIM models to develop maintenance plans, schedules, and task assignments, optimizing maintenance activities and resource allocation.

e. Predictive Maintenance: Implement predictive maintenance strategies using BIM data analytics to anticipate equipment failures, reduce downtime, and extend asset lifecycles.

f. Space Management: Utilize BIM models for space planning, allocation, and utilization analysis, optimizing space usage and occupancy efficiency.

g. Energy Analysis and Sustainability: Conduct energy analysis and sustainability assessments using BIM models to identify opportunities for energy savings and carbon footprint reduction.

h. Facility Documentation: Manage the creation and maintenance of facility documentation (e.g., as-built drawings, equipment manuals) within BIM models, ensuring accuracy and completeness.

i. Integration with CMMS: Integrate BIM data with Computerized Maintenance Management Systems (CMMS) for streamlined facility management workflows and data exchange.

j. Training and Support: Provide training and support to operations teams on BIM tools, workflows, and best practices, promoting adoption and proficiency across the organization.

6. Coordinator – Project Strategy.

Developing project strategies, EIR, BEP, CDE and Soft-landing Strategies. Create templates, roadmaps, workflows for standardizing BIM Implementation across projects.

a. BIM Strategy Development: Develop and implement BIM strategies tailored to project requirements and objectives, aligning with overall project goals and client expectations.

b. Project Planning and Execution: Collaborate with project teams to develop BIM execution plans (BEPs), outlining BIM requirements, processes, and deliverables for each project phase.

c. BIM Integration: Ensure the seamless integration of BIM into project workflows, from conceptual design through construction and facility management

d. Quality Assurance: Establish and enforce BIM standards, protocols, and best practices to ensure the accuracy, consistency, and quality of BIM deliverables.

e. Innovation and Best Practices: Stay abreast of industry trends, emerging technologies, and best practices related to BIM, and integrate relevant advancements into project strategies.

f. Interdisciplinary Coordination: Facilitate interdisciplinary coordination and collaboration through the use of BIM, promoting integrated project delivery and minimizing conflicts and rework.

g. Client Engagement: Engage with clients to understand their BIM requirements and expectations, and tailor project strategies to meet their needs.

h. Risk Management: Identify and mitigate risks associated with BIM implementation, ensuring compliance with contractual obligations and regulatory requirements.

i. Training and Support: Provide training and support to project teams on BIM tools, workflows, and best practices, fostering a culture of continuous learning and improvement.

j. Performance Measurement: Establish key performance indicators (KPIs) and metrics to measure the effectiveness and impact of BIM strategies on project outcomes.

7. Coordinator – BIM Trainings.

Responsible for developing and delivering BIM training programs to support the adoption and proficiency of BIM workflows across our organization. They will play a critical role in empowering our teams with the skills and knowledge needed to leverage BIM effectively in their projects.

a. Training Program Development: Develop comprehensive BIM training programs tailored to the needs and skill levels of various teams and individuals within the organization.

b. Training Delivery: Facilitate engaging and interactive BIM training sessions, workshops, and seminars for employees at all levels, both in-person and virtually in coordination with service providers.

c. Content Creation: Manage and curate training materials, resources, and documentation, including tutorials, guides, videos, and online courses, to support ongoing learning and development.

d. Skills Assessment: Conduct skills assessments and proficiency evaluations to identify training needs and track progress in BIM competency across the organization.

e. Continuous Improvement: Evaluate training effectiveness and gather feedback from participants to continuously improve training programs and ensure alignment with organizational goals and objectives.

8. Coordinator – BIM Partnerships.

Responsible for developing and managing strategic partnerships with key stakeholders in the BIM ecosystem, including solution and service providers, industry organizations, academic institutions, and other AEC firms. They will play a pivotal role in strengthening our network, fostering collaboration, and driving innovation in BIM and Digital adoption.

a. Partnership Development: Identify and cultivate strategic partnerships with BIM solution and service providers, industry organizations, academic institutions, and other relevant stakeholders to support our BIM initiatives and goals.

b. Relationship Management: Build and maintain strong relationships with partner organizations, serving as the primary point of contact and fostering collaboration on joint initiatives and projects.

c. Collaboration Facilitation: Facilitate collaboration and knowledge exchange between our organization and partner organizations, organizing meetings, workshops, and events to share best practices, insights, and innovations in BIM implementation.

d. Resource Sharing: Coordinate the sharing of resources, tools, and expertise between partner organizations and our team to enhance our capabilities and support mutual objectives in BIM adoption and advancement.

e. Opportunity Identification: Identify opportunities for joint research, development, and innovation projects with partner organizations, leveraging their expertise and resources to drive innovation and excellence in BIM implementation.

f. Contract Negotiation: Negotiate partnership agreements, contracts, and memoranda of understanding (MOUs) with partner organizations, ensuring alignment with organizational goals and objectives.

9. Coordinator – CDE Platform.

Responsible for setting up and managing our CDE platform. Support project teams in utilizing BIM data effectively throughout the project lifecycle. They will play a critical role in ensuring data integrity, facilitating collaboration, and optimizing workflows within our organization.

a. CDE Administration: Oversee the administration of our CDE platform, including user management, permissions control, and data organization, to ensure efficient and secure access to project information.

b. Data Management: Manage the upload, organization, and version control of BIM data and documentation within the CDE, ensuring accuracy, consistency, and compliance with project standards and protocols.

c. Workflow Optimization: Work closely with project teams to understand their workflows and requirements and customize the CDE platform to optimize collaboration, communication, and data exchange throughout the project lifecycle.

d. Quality Assurance: Conduct regular audits and checks on CDE data and documentation to ensure compliance with BIM standards, project requirements, and industry best practices.

e. Integration with BIM Software: Coordinate the integration of our CDE platform with BIM authoring tools, coordination software, and other project management systems to streamline data exchange and synchronization.

f. Documentation and Reporting: Maintain documentation of CDE processes, workflows, and configurations, and prepare regular reports on CDE usage, performance, and effectiveness for internal stakeholders.

g. Compliance and Security: Ensure compliance with relevant data protection regulations and industry standards for data security and privacy, implementing measures to safeguard sensitive project information within the CDE.

10. Coordinator – Smart Contracts.

Responsible for developing, designing, implementing, and managing smart contracts (BIM and Block-chain integration) within Building Information Modelling workflows and improve automation, transparency, and efficiency in project delivery.

a. Smart Contract Design: Design and develop smart contracts tailored to project requirements, defining contractual agreements and conditions within BIM workflows.

b. Blockchain Integration: Integrate smart contracts with blockchain technology to ensure immutability, security, and transparency of contract execution and data exchange.

c. Automation and Optimization: Implement smart contracts to automate routine tasks and processes within BIM workflows, optimizing project delivery and reducing administrative overhead.

d. Data Management: Manage and maintain BIM data within smart contracts, ensuring accuracy, integrity, and accessibility for project stakeholders.

e. Risk Management: Implement smart contracts to manage and mitigate project risks, including payment terms, deliverables, and compliance with contractual obligations.

f. Interoperability: Ensure interoperability between smart contracts and BIM software tools, facilitating seamless data exchange and integration across project phases.

g. Contract Performance Monitoring: Monitor and track the performance of smart contracts, including key performance indicators (KPIs) and metrics, to assess contract effectiveness and compliance.

h. Stakeholder Engagement: Engage with project stakeholders to communicate the benefits and implications of smart contracts in BIM workflows, fostering adoption and collaboration.

i. Training and Support: Provide training and support to project teams on smart contract implementation and use within BIM workflows, promoting proficiency and confidence in adoption.

j. Continuous Improvement: Stay abreast of emerging trends, technologies, and best practices in smart contracts and BIM, and identify opportunities for continuous improvement and innovation.

11. Coordinator – ROI Documentation.

Responsible for documenting and analysing the return on investment (ROI) of our BIM implementation efforts. Play a crucial role in quantifying the benefits of BIM adoption, identifying areas for improvement, and optimizing our BIM workflows to maximize value delivery.

a. ROI Measurement: Develop and implement metrics and methodologies for measuring the ROI of BIM implementation across our projects, considering factors such as time savings, cost reductions, quality improvements, and client satisfaction.

b. Data Collection: Gather data and documentation from project teams, stakeholders, and project management systems to track and document the impact of BIM on project performance and outcomes.

c. Analysis and Reporting: Analyse ROI data and metrics to identify trends, patterns, and opportunities for improvement in BIM workflows and processes, and prepare regular reports and presentations for internal stakeholders.

d. Case Studies: Develop detailed case studies and success stories highlighting the tangible benefits and value generated by implementing BIM in specific projects or use cases, showcasing our organization’s expertise and leadership in BIM adoption.

e. Best Practices Documentation: Document best practices, lessons learned, and success factors from BIM implementation projects, and develop guidelines, templates, and resources to support consistent and effective BIM adoption across our organization.

12. Coordinator - BIM - Architecture & Landscape.

Plays a key role in driving the implementation of BIM processes and workflows for architecture and landscape projects. Will be responsible for coordinating BIM activities, managing BIM models, facilitating collaboration among project stakeholders, and ensuring adherence to BIM standards and protocols. Responsibilities are as mentioned below:-

a. BIM Implementation: Lead the implementation of BIM methodologies and workflows within the architecture and landscape design teams, including the adoption of BIM authoring tools and collaboration platforms.

b. Project Coordination: Collaborate with architects, landscape architects, engineers, and other project stakeholders to coordinate BIM processes and workflows throughout the project lifecycle, from conceptual design to construction documentation.

c. Model Development: Oversee the development and maintenance of BIM models for architectural and landscape elements, ensuring accuracy, completeness, and compliance with project requirements and industry standards.

d. Interdisciplinary Integration: Facilitate interdisciplinary coordination and collaboration between architectural and landscape design teams, ensuring seamless integration of BIM models and data across disciplines.

e. Quality Assurance: Conduct regular reviews and audits of BIM models and documentation to ensure adherence to BIM standards, best practices, and project requirements, and implement corrective actions as needed.

13. Coordinator - BIM for Structural & Formwork.

Responsible for leading the integration of BIM methodologies and technologies into our structural design and formwork processes. Collaborates closely with project teams, subcontractors, and stakeholders to optimize structural design and formwork solutions through effective BIM implementation.

a. BIM Model Development: Lead the development of detailed BIM models for structural elements and formwork systems, ensuring accuracy, completeness, and compliance with project requirements and industry standards.

b. Interdisciplinary Coordination: Facilitate coordination meetings between architecture, engineering, and formwork teams to ensure seamless integration of BIM models and data and resolve interdisciplinary conflicts.

c. Formwork Planning and Optimization: Collaborate with formwork engineers and subcontractors to develop formwork planning strategies, optimize formwork systems, and simulate construction sequences using BIM-enabled visualization and analysis tools.

d. Quantity Take-off and Estimation: Utilize BIM models to perform accurate quantity take-off, generate material estimates for structural elements and formwork systems, and support procurement and cost estimation activities.

e. BIM Standards and Quality Assurance: Establish and enforce BIM standards and protocols specific to structural design and formwork modelling, conduct regular reviews and audits of BIM models to ensure adherence to standards and best practices.

14. Coordinator - BIM for MEPF

Leading the implementation of BIM workflows and technologies within our MEPF design and coordination processes. They will collaborate closely with project teams, subcontractors, and stakeholders to optimize MEPF systems and ensure seamless coordination and collaboration through effective BIM implementation.

a. MEPF Model Development: Manage the development of detailed BIM models for mechanical, electrical, plumbing, and fire protection systems in coordination with internal and external stakeholders. Electrical alarm system modelling.

b. Interdisciplinary Coordination: Facilitate coordination meetings between MEPF design teams, architects, engineers, and other project stakeholders to integrate MEPF systems seamlessly and resolve clashes and conflicts.

c. Clash Detection and Resolution: Utilize BIM-enabled clash detection tools to identify clashes and conflicts between MEPF systems, structural elements, and architectural features, and coordinate resolution efforts.

d. Quantity Take-off and Estimation: Perform accurate quantity take-off and generate material estimates for MEPF systems using BIM models, supporting procurement and cost estimation activities.

e. BIM Standards and Quality Assurance: Establish and enforce BIM standards and protocols specific to MEPF design and coordination, conduct regular reviews and audits of BIM models to ensure compliance with standards and best practices.

f. Training and Support: Provide training and support to MEPF design teams and subcontractors on BIM software tools, workflows, and methodologies, empowering them to leverage BIM effectively in their projects.

15. Coordinator - Interior Design.

Responsible for leading the interior design and modelling for our projects based on inputs from our national and international consultants. Will also have to collaborate closely with architects, engineers, and clients to translate design concepts into detailed models for visualization.

a. BIM Leadership: Provide interior design-focused leadership and guidance to the BIM team, ensuring alignment with project goals and design objectives.

b. Design Development: Lead the development of interior design concepts and solutions using BIM software tools.

c. Parametric Modelling: Utilize parametric modelling techniques to explore design alternatives, optimize space utilization, and enhance design flexibility.

d. Visualization and Presentation: Create compelling visualizations and presentations using BIM models to communicate design concepts and ideas effectively to clients and stakeholders. Integrate the BIM models with the experience centre/VR/AR/MR for delivering immersive experience.

e. Material and Finishes Selection: Collaborate with project teams to select materials, finishes, and furnishings within BIM models, ensuring adherence to design intent and project requirements.

f. Collaboration and Coordination: Facilitate interdisciplinary collaboration and coordination with architects, engineers, and contractors through the use of BIM, promoting integrated project delivery.

g. Code Compliance: Ensure interior design solutions comply with relevant building codes, regulations, and standards, integrate code requirements into BIM models.

h. Construction Documentation: Generate construction documentation (e.g., interior elevations, details, schedules) within BIM models, ensuring accuracy and completeness for construction implementation.

i. Quality Assurance: Conduct regular quality control checks on BIM models to ensure accuracy, consistency, and compliance with design standards and project requirements.

j. Training and Support: Provide training and support to interior design teams on BIM tools, workflows, and best practices, fostering adoption and proficiency across the organization.

16. Coordinator – Clash Detection and Resolution.

Responsible for overseeing clash detection processes and coordinating resolution efforts to mitigate clashes and conflicts between various building systems and components. Also, collaborate closely with project teams, subcontractors, and stakeholders to optimize project workflows and ensure project delivery with minimal disruptions.

a. Clash Detection Management: Oversee clash detection processes using BIM software tools ensuring comprehensive coverage of all building systems and components.

b. Clash Identification: Analyse clash reports generated by BIM software to identify clashes and conflicts between architectural, structural, MEPF, Interior and other building systems.

c. Resolution Coordination: Collaborate with project teams, subcontractors, and stakeholders to coordinate clash resolution efforts, prioritize clashes based on severity and impact, and develop practical solutions to resolve conflicts.

d. Interdisciplinary Collaboration: Facilitate coordination meetings between various project disciplines to discuss clash resolution strategies, coordinate design changes, and ensure alignment with project goals and objectives.

e. Documentation and Reporting: Maintain detailed records of clashes and resolution actions, prepare clash status reports and updates for project stakeholders, and track resolution progress to closure.

17. Coordinator – BIM for Experience.

Responsible for creating an immersive and interactive experience that showcases our projects and capabilities through advanced BIM visualization techniques and VR devices. Collaborate closely with project teams, clients, and stakeholders to develop compelling visualizations that enhance project understanding and decision-making.

a. Experience Centre Development: Lead the development of the BIM Visualization Experience Centre, including the design of physical space, selection of technology and equipment, and creation of interactive exhibits.

b. Project Visualization: Collaborate with project teams to develop high-quality BIM visualizations, renderings, animations, and virtual, augmented and mixed reality experiences that showcase project design, construction progress, and completed works.

c. Stakeholder Engagement: Engage with clients, investors, regulators, and other stakeholders to understand their visualization needs and preferences, and tailor visualizations to effectively communicate project concepts and outcomes.

d. Technology Integration: Stay abreast of emerging technologies and trends in BIM visualization, VR, augmented reality (AR), and mixed reality (MR), and evaluate and integrate relevant technologies into the Experience Center to enhance visitor experience.

e. Training and Support: Provide training and support to internal teams on BIM visualization tools and techniques and facilitate client workshops and demonstrations to showcase the capabilities of the Experience Centre.

18. Coordinator – Modular Construction.

Responsible for driving the integration of BIM processes and technologies into our prefab and modular construction elements within our projects (including 3D Printing and DFMA). Will play a pivotal role in optimizing modular construction workflows, enhancing collaboration, and ensuring the seamless integration of BIM across all phases of our projects.

a. BIM Strategy Development: Develop and implement BIM strategies tailored to modular construction projects, aligning with project goals and objectives.

b. Modular Design Development: Lead the development of modular design solutions using BIM software tools, optimizing design for manufacturing and assembly (DFMA) principles.

c. Component Standardization: Standardize modular components and assemblies within BIM models to maximize efficiency and scalability in manufacturing.

d. Manufacturing Documentation: Generate manufacturing documentation (e.g., shop drawings, fabrication models) within BIM models, ensuring accuracy and completeness for offsite production.

e. Assembly Sequencing: Develop assembly sequences and installation instructions using BIM models to streamline onsite construction and assembly processes.

f. Interdisciplinary Coordination: Facilitate interdisciplinary coordination and collaboration through the use of BIM, ensuring seamless integration of architectural, structural, and MEP systems within modular designs.

g. Quality Control: Conduct regular quality control checks on modular designs and components within BIM models to ensure compliance with manufacturing standards and project requirements.

h. Material Management: Manage material quantities and specifications within BIM models, facilitating procurement and inventory management for modular construction projects.

i. Training and Support: Provide training and support to project teams on BIM tools, workflows, and best practices for modular construction, promoting adoption and proficiency across the organization.

j. Continuous Improvement: Identify opportunities for process improvement and innovation in modular construction workflows, leveraging BIM tools and technologies to drive efficiency and sustainability.

19. Coordinator – BIM for Time Planning & Monitoring.

Responsible for overseeing project scheduling, progress tracking, and time-related data management using BIM tools and techniques. Collaborate closely with project teams, subcontractors, and stakeholders to develop and maintain accurate project schedules and monitor progress throughout all project phases.

a. Project Scheduling: Develop and maintain detailed project schedules using BIM software tools ensuring alignment with project goals, milestones, and deliverables.

b. Progress Tracking: Monitor project progress against established schedules, track completion of tasks and activities, and identify deviations and delays using BIM-enabled progress tracking features.

c. Resource Allocation: Coordinate with project teams to allocate resources effectively, optimize workflow sequences, and identify opportunities for schedule acceleration or optimization.

d. Time-related Data Management: Manage time-related data such as construction sequences, lead times, and durations within BIM models, ensuring accuracy and consistency across project documentation and schedules.

e. Collaboration and Communication: Facilitate communication and collaboration between project teams, subcontractors, and stakeholders regarding project schedules, progress updates, and time-related issues.

f. Risk Identification and Mitigation: Identify potential schedule risks and constraints, assess their impact on project timelines, and develop mitigation strategies to minimize schedule disruptions.

20. Coordinator – Drone Deployment (Reality Capture)

Leveraging reality capture technologies (such as laser scanning, photogrammetry, and drones) to capture accurate as-built conditions and integrate them into BIM workflows. Will play a critical role in enhancing project visualization, coordination, and decision-making through the use of reality capture data within BIM models.

a. Reality Capture Planning: Plan and coordinate reality capture activities for projects, including the selection of appropriate reality capture technologies and equipment.

b. Data Acquisition: Conduct reality capture data acquisition using laser scanning, photogrammetry, drones, 360-degree cameras and other reality capture technologies to capture accurate as-built conditions.

c. Data Processing: Process reality capture data using specialized software tools to generate point clouds, 3D models, and other digital representations of existing conditions.

d. Integration with BIM: Integrate reality capture data into BIM software platforms ensuring alignment with project requirements and design intent.

e. Model Registration: Register reality capture data with BIM models to ensure accurate alignment and coordination between the digital model and the physical environment.

f. Visualization and Analysis: Use reality capture data within BIM models for visualization, analysis, and simulation purposes, enabling better-informed decision-making and project coordination.

g. Documentation and Reporting: Generate documentation and reports based on reality capture data, providing stakeholders with insights into existing conditions and project progress.

h. Training and Support: Provide training and support to project teams on reality capture technologies and workflows, promoting adoption and proficiency across the organization.

i. Quality Assurance: Conduct regular quality control checks on reality capture data and its integration into BIM models to ensure accuracy, completeness, and compliance with project standards.

21. Coordinator – Safety and Risk Area

Responsible for identifying, assessing, and mitigating risks associated with construction projects using BIM methodologies and technologies. Collaborate closely with project teams, subcontractors, and safety personnel to develop comprehensive risk management and safety plans that enhance project safety and reduce potential liabilities.

a. Risk Identification: Identify potential risks and hazards associated with construction projects, including design, scheduling, logistics, and site conditions, using BIM-enabled risk identification techniques.

b. Risk Assessment: Assess the severity and likelihood of identified risks, analyse their potential impact on project objectives, and prioritize risks for mitigation based on their level of significance.

c. Risk Mitigation: Develop and implement risk mitigation strategies and controls, such as design modifications, process improvements, and safety protocols, to minimize the likelihood and impact of identified risks.

d. Safety Planning: Collaborate with project teams and safety personnel to develop comprehensive safety plans and procedures, incorporating BIM data and visualizations to enhance safety awareness and compliance.

e. Safety Monitoring: Monitor project activities and site conditions using BIM-enabled safety monitoring tools and techniques, identify potential safety violations or hazards, and take corrective actions to address safety concerns.

f. Documentation and Reporting: Maintain detailed records of identified risks, risk assessments, mitigation actions, safety plans, and safety monitoring activities, and prepare regular reports and updates for project stakeholders and senior management.

22. Coordinator – BIM for Cost Planning and Monitoring

Coordinate and oversee cost planning and monitoring processes using BIM methodologies and technologies. Collaborate closely with project teams, estimators, and stakeholders to develop accurate cost estimates, monitor project costs, and identify cost-saving opportunities throughout the project lifecycle.

a. Cost Estimation: Utilize BIM software tools such to develop detailed cost estimates for construction projects based on BIM models and project specifications.

b. Cost Planning: Develop and maintain comprehensive cost plans and budgets, incorporating data from BIM models, project schedules, and procurement documents to ensure alignment with project objectives.

c. Cost Monitoring: Monitor project costs against established budgets, track expenditures and commitments, and identify variances and trends using BIM-enabled cost monitoring features.

d. Value Engineering: Collaborate with project teams to identify cost-saving opportunities through value engineering and alternative design solutions, and assess the impact of proposed changes on project costs and performance.

e. Change Management: Manage changes to project scope, specifications, and requirements, assess their impact on project costs, and update cost plans and budgets accordingly using BIM-derived data.

f. Documentation and Reporting: Maintain detailed records of cost estimates, cost plans, change orders, and cost monitoring activities, and prepare regular reports and updates for project stakeholders and senior management.

23. Coordinator – BIM for Procurement & Logistics Planning.

Responsible for overseeing procurement and logistics planning processes using BIM methodologies and technologies. They will collaborate closely with project teams, suppliers, and logistics providers to optimize procurement workflows, streamline supply chain operations, and ensure timely delivery of materials and equipment to project sites.

a. Procurement Management: Utilize BIM software tools to manage procurement processes, including request for proposals (RFPs), bid evaluations, vendor selection, and contract management.

b. Logistics Planning: Develop and maintain comprehensive logistics plans for construction projects, including transportation, warehousing, and distribution strategies, to ensure timely delivery of materials and equipment to project sites.

c. Inventory Management: Implement BIM-enabled inventory management systems to track material quantities, locations, and usage on project sites, optimize inventory levels, and minimize stockouts and excess inventory.

d. Change Management: Manage changes to procurement and logistics plans, assess their impact on project timelines and budgets, and update plans and schedules accordingly using BIM-derived data.

e. Documentation and Reporting: Maintain detailed records of procurement activities, logistics plans, material inventories, and delivery schedules, and prepare regular reports and updates for project stakeholders and senior management.

24. Coordinator – Scanner Deployment

Responsible for deploying and operating 3D scanners to capture accurate as-built data for BIM models. They will collaborate closely with project teams, surveyors, and subcontractors to ensure the successful deployment of scanners and the seamless integration of scan data into BIM workflows.

a. Scanner Deployment: Lead the deployment and setup of 3D scanners on construction sites, ensuring proper calibration and alignment for accurate data capture.

b. Scan Data Acquisition: Coordinate with project teams and surveyors to capture as-built data using 3D scanners, ensuring comprehensive coverage of project sites and structures.

c. Data Processing: Process and register scan data using software tools ensuring alignment and accuracy of scan data for BIM modelling.

d. BIM Integration: Integrate scan data into BIM workflows, including point cloud registration, model alignment, and clash detection, to facilitate as-built modelling and coordination.

e. Quality Assurance: Conduct quality checks on scan data to ensure accuracy and completeness, and collaborate with project teams to address any discrepancies or issues.

f. Training and Support: Provide training and support to project teams and subcontractors on scanner operation, data capture techniques, and scan data processing, ensuring proficiency in scanner deployment and utilization.

g. Documentation and Reporting: Maintain detailed records of scanner deployments, scan data acquisition, and data processing activities, and prepare regular reports and updates for project stakeholders and senior management.

25. Coordinator – Digital Twin Strategy.

Responsible for developing and implementing digital twin strategies for BIM. Play a key role in finalizing construction layout, As-Built models, data normalization, virtual handover and add value at asset management phase for our clients.

a. Digital Twin Strategy Development: Develop and implement digital twin strategies tailored to project requirements and objectives, aligning with overall project goals and client expectations.

b. BIM Integration: Integrate BIM data with digital-twin platforms and technologies to create accurate, dynamic, and data-rich digital representations of built assets.

c. Data Visualization and Analysis: Use digital twins for real-time visualization, analysis, and simulation of building performance metrics such as energy consumption, occupant comfort, and maintenance requirements.

d. IoT Sensor Integration: Integrate Internet of Things (IoT) sensors and devices with digital twin platforms to collect real-time data on building operations, occupancy, and environmental conditions.

e. Predictive Analytics: Implement predictive analytics algorithms within digital-twins to forecast asset performance, anticipate maintenance needs, and optimize operational efficiency.

f. Lifecycle Management: Utilize digital-twins for lifecycle management of built assets, from design and construction through operations and maintenance, enabling informed decision-making at every stage.

g. Stakeholder Engagement: Engage with project stakeholders to communicate the benefits and implications of digital twins, fostering collaboration and alignment on digital twin strategies and objectives.

h. Training and Support: Provide training and support to project teams on digital twin technologies and workflows, promoting adoption and proficiency across the organization.

i. Continuous Improvement: Identify opportunities for process improvement and innovation in digital twin workflows, leveraging emerging technologies and best practices to enhance digital twin capabilities.

j. Quality Assurance: Conduct regular quality control checks on digital twin data and models to ensure accuracy, reliability, and compliance with project standards and requirements.

26. Coordinator – Sustainability

Responsible for integrating sustainability principles and practices into BIM workflows to promote environmentally responsible design, construction, and operation of buildings. They will collaborate closely with project teams, sustainability consultants, and stakeholders to develop and implement sustainable strategies and initiatives using BIM-enabled tools and technologies. Coordinate for Sustainability Certifications with stakeholders.

a. Sustainable Design Integration: Collaborate with architects, engineers, and designers to integrate sustainability criteria and performance metrics into BIM models from the early stages of design development.

b. Energy and Environmental Analysis: Conduct energy modelling, daylight analysis, sun studies, System analysis, mechanical analysis, and environmental assessments using BIM software tools to optimize building performance and reduce environmental impact.

c. Material Selection and Lifecycle Analysis: Evaluate building materials and components for sustainability attributes, including embodied carbon, life cycle assessment (LCA), and environmental product declarations (EPDs), and integrate sustainable materials data into BIM models.

d. Green Building Certification: Facilitate the certification process for green building rating systems such as LEED, GRIHA etc. by leveraging BIM data and documentation to demonstrate compliance with sustainability criteria and requirements.

e. Sustainable Construction Practices: Collaborate with construction teams to implement sustainable construction practices and strategies, such as waste reduction, recycling, and use of renewable materials, and track sustainability performance metrics throughout the construction process.

f. Occupancy and Operations Optimization: Support building owners and facility managers in leveraging BIM data for ongoing sustainability optimization, including energy monitoring, indoor environmental quality (IEQ) assessments, and occupant comfort evaluations.

27. Coordinator – Building Automation

Responsible for integrating building automation systems with BIM workflows to create intelligent, data-driven building models. They will play a crucial role in optimizing building performance, streamlining operations, and enhancing occupant experience through the use of automation technologies within BIM.

a. IM Integration: Integrate building automation systems and data with BIM platforms.

b. Automation System Design: Design automation systems for building services such as HVAC, lighting, and security, ensuring compatibility with BIM workflows and standards.

c. Parametric Modelling: Utilize parametric modelling techniques within BIM to simulate and optimize building performance based on automation system data and parameters.

d. Data Visualization and Analysis: Use BIM models to visualize and analyse building performance metrics such as energy consumption, indoor air quality, and occupant comfort, enabling data-driven decision-making.

e. Simulation and Optimization: Conduct simulations and optimizations within BIM models to identify opportunities for energy savings, operational efficiency, and sustainability improvements.

f. Interdisciplinary Coordination: Collaborate with architects, engineers, and contractors to ensure seamless integration of automation systems and BIM data throughout the project lifecycle.

g. Lifecycle Management: Utilize BIM models for lifecycle management of automation systems, from design and installation through operations and maintenance, enabling predictive maintenance and performance monitoring.

h. Stakeholder Engagement: Engage with project stakeholders to communicate the benefits and implications of building automation for BIM, fostering collaboration and alignment on automation strategies and objectives.

i. Training and Support: Provide training and support to project teams on building automation technologies and workflows, promoting adoption and proficiency across the organization.

j. Continuous Improvement: Identify opportunities for process improvement and innovation in building automation workflows, leveraging emerging technologies and best practices to enhance automation capabilities.

28. Coordinator – BIM for Asset Operation

Responsible for coordinating asset operation and maintenance activities using BIM methodologies and technologies. They will collaborate closely with facility managers, maintenance teams, and building owners to leverage BIM data for efficient asset management, predictive maintenance, and performance optimization. Responsibilities are as mentioned below:-

a. Asset Data Management: Manage BIM data related to building assets, including equipment, systems, and components, to ensure accuracy, completeness, and consistency throughout the asset lifecycle.

b. Maintenance Planning: Develop and maintain comprehensive maintenance plans and schedules based on asset data and performance criteria, using BIM-enabled tools.

c. Predictive Maintenance: Implement predictive maintenance strategies using BIM data and analytics to anticipate equipment failures, optimize maintenance intervals, and minimize downtime and disruptions.

d. Performance Monitoring: Monitor asset performance using real-time data from sensors and IoT devices integrated with BIM models and analyse performance trends to identify optimization opportunities and improve operational efficiency.

e. Compliance and Regulation: Ensure compliance with regulatory requirements and industry standards for asset operation and maintenance and utilize BIM data to document and track compliance activities.

f. Training and Support: Provide training and support to facility managers and maintenance teams on utilizing BIM data for asset management and operations and facilitate knowledge transfer and skill development to enhance team capabilities.

29. Coordinator – Geo-BIM Strategy.

Responsible for integrating geospatial data and BIM models to enhance project planning, design coordination, and construction management. Collaborate closely with project teams, GIS specialists, and stakeholders to leverage geospatial and BIM technologies for improved spatial analysis, visualization, and decision support.

a. Data Integration: Integrate geospatial data from Geographic Information Systems (GIS) with BIM models using interoperability standards and data exchange formats, ensuring alignment and consistency between spatial datasets and BIM elements.

b. Spatial Analysis: Conduct spatial analysis and geospatial modelling using GIS tools to inform site selection, environmental assessments, and infrastructure planning, and leverage BIM data to enhance spatial visualization and analysis.

c. Design Coordination: Facilitate design coordination and clash detection using integrated geospatial and BIM data, identifying spatial conflicts and coordination issues early in the design process to mitigate risks and optimize project outcomes.

d. Construction Management: Support construction management activities by utilizing integrated geospatial and BIM data for site logistics planning, progress tracking, and spatial visualization of construction activities, enabling better coordination and communication among project stakeholders.

e. Asset Management: Leverage integrated geospatial and BIM data for asset management and facility operations, including spatially enabled asset inventories, condition assessments, and maintenance planning, to optimize asset performance and lifecycle management.

f. Training and Support: Provide training and support to project teams and stakeholders on utilizing integrated geospatial and BIM data for improved project planning, design coordination, and construction management, and facilitate knowledge transfer to enhance team capabilities.

10. Glossary of Term

- *Aggregate Model:* A model which forms part of a larger model. An Aggregate Model may be a single building model aggregated into a site model or a Mono-Discipline Model aggregated into a Multi-Discipline Model. Aggregation - as a term - applies to both Integrated Models and Federated Models
- *Annotation Element:* Refer to text, symbols, keynote, section tags, level markers and similar symbols used to add visible information to models and 2D Drawings. Annotation Elements may (or may not) be explicit representations of embedded BIM model data
- *Asset*: An asset is an entity of value. In Asset Management, an asset refers to physical entities of tangible financial value similar to buildings, land, equipment, and inventory
- *Asset Information Management*: A discipline or specialty dedicated to administering asset-related data and organizational information [adapted from PAS1192-3]
- *Asset Information Requirement*: The data or information requirements related to an Asset. Asset Information Requirements (AIR) are typically fed into the Asset Information Model and form part of the Employer's Information Requirements
- *Asset Life Cycle*: Refers to all asset phases: from planning, through design, construction and use/maintenance till disposal. Asset Life Cycle phases are typically used for establishing change in asset utilization, depreciation, Life Cycle Cost, Life Cycle Expenditure, and Life Cycle Assessment Similar terms: Facility Life Cycle
- *Asset Maintenance*: BIM-enabled Asset Maintenance is characterized by linking virtual objects within 3D models to an external database capable of managing maintenance tasks and workflows. Asset Maintenance is a subset of Asset Management
- *Asset Management*: BIM-enabled Asset Management is characterized by linking virtual objects and spaces within a model to an external database for the purpose of operating and maintaining a facility or a portfolio of facilities
- *Assert Management System*: An organizational system to manage Asset data and their related information. An Asset Management System may refer to a digital platform or a set of internal processes/protocols
- *BIM Collaboration Event*: A meeting, presentation or workshop conducted as part of a Collaborative BIM Project. An event may be conducted in meeting room, Immersive Environment or online and includes at least two Project Participants
- *BIM Deliverable*: A general term referring to BIM Models, Model Components, Model Uses and all other project/process deliverables expected out of using BIM tools and workflow
- *BIM Hardware*: Computers, equipment and peripherals used for the purpose of generating BIM models and their Model Uses. BIM hardware thus refers to laptops, tablets, desktops, 3D Laser Scanners, cameras, 2D/3D printers and any piece of equipment necessary to generate BIM Deliverable.
- *BIM Level*: An articulation of the levels of competence expected, its supporting standards and guidance notes, their relationship to each other, and how they can be applied to projects and contracts.

Refer to Level 0 BIM, Level 1 BIM, Level 2 BIM, and Level 3 BIM. BIM Levels are specific to the UK and are not be confused with the research-based BIM Stages (1, 2 and 3) or BIM Maturity Levels (a, b, c, d and e)

- *BIM / FM Integration*: The technologies and processes needed to integrate BIM models with Facility Management deliverables, databases and workflows

- *BIM Model*: Building Information Models (BIM models) are the generic object -based 3D models generated by any Project Participant using an 'accredited' BIM Software Tool

- *CIC BIM Protocol:* A template/document identifying the models/information to be produced by project team members and establishing their associated responsibilities, liabilities and limitations. The CIC BIM Protocol aligns with PAS 1192-2 and appends contracts between Employers and Supplier

- *Clash Detection:* Using 3D models to coordinate different disciplines (e.g., structural and mechanical) and to identify/ resolve possible clashes between virtual elements prior to actual construction or fabrication. Also refer to Clash Avoidance

- *COBie:* COBie (Construction Operations Building Information Exchange) is a specification for the capture and delivery of design/construction information to facility managers. COBie specifications can be viewed as a simple spreadsheet or embedded into design, construction, and operation BIM models. Please note that COBie may have different uses in US, UK and other countries

- *Common BIM Terminology:* A set of terms (similar to Clash Detection, COBie, model author, etc…) which a BIM user is expected to know and understand. Common BIM Terminology can be used as a BIM Metric to measure Project Team compatibility or the quality of BIM Guides and Manual

- *Common Data Environment:* A single source of information which collects, manages and disseminates relevant, approved project documents for multi-disciplinary teams in a managed process. A Common Data Environment (CDE) is served by a Model Server and/or a Document Management System that facilitates the sharing of data/information among Project Participants. Information within a CDE need to carry one of four labels (or reside within one of four areas): Work In Progress Area, Shared Area, Published Area, and Archive Area

- *Computer- Aided Facility Management:* A Computer System supporting the activities required for Facility Management. CAFM systems allow Facility Managers to monitor the operational requirements of buildings (e.g. energy consumption, lighting, security, etc.), manage space utilization, track asset/equipment locations, and perform other related functions during the Operation Phase of a facility

- *Error - Free Model:* An error-free model refers to BIM models which are judged to include no or an insignificant number of 'true positive' errors - real errors which affect constructability, data integrity or similarly serious issues. An error-free model should not be confused with a 'zero-error' model which may include 100s or even 1000s of 'false-positives' - errors reported by automated checking systems but are not considered - by informed humans - to be of significance. Also refer to Modelling Error, Model Validation and Model Quality

- *Federated Model:* A BIM model which links (does not merge) several Mono-Discipline Models together. As opposed to Integrated Models, Federated Models do not merge the properties of individual models into a single database. It is also sometimes referred as Linked Model.

- *Level of Development:* A BIM metric to identify what information to include in a model during the design and construction process (also refer to Model Progression Specifications). Please note that the LOD abbreviation refers to multiple terms, definitions, and numbering systems even within the same country.
- *Level of Information Detail:* LID is a BIM Metric (developed by Change Agents) that measures the extent of information included within any requirement or deliverable. As opposed to Level of Development (LOD) which applies exclusively to BIM models and model elements, the LID index applies to models, drawings, documents, views and all other information formats. Another main difference from LOD is that LID does not automatically equate more information with higher development
- *Model Component:* A virtual element representing a physical building object. Model Components may be parametrically driven, 2D or 3D, and may also represent abstract items (e.g. North Arrow
- *Modelling Error:* Modelling errors are many types including: missing elements, wrong category of elements, lack of data within elements, unsuitable Level of Development, overlapping elements, wrong material, wrong position or orientation. Also refer to Error-Free Model, Model Validation and Model Quality
- *Project BIM Manager:* A BIM Role played by an individual or an organization on behalf of the whole Project Team. The Project BIM Manager has many responsibilities (typically defined with the BIM Management Plan) which include: BIM Facilitation, coordinating data-exchange activities, fulfilling pre- defined Design Specifications and Delivery Specifications, and overall Model Quality control
- *Request for Information:* RFI is a process whereby a Project Participant (e.g. a contractor) sends a note to another participant (e.g. and architect) to confirm the interpretation of what is documented or to seek clarification of what is specified within a 2D Drawing or a BIM model
- *Spatial Coordination:* A Model Use representing the utilization of BIM models to coordinate the placement of objects and account for their spatial requirements (e.g. access panels and keep-clear areas) within a 3D space. Also refer to Clash Avoidance and Clash Detection
- *Standard:* Detailed set of product/service descriptions (prescriptive or performance-based) acting as a reference to be measured against. Standards typically denote a set of Specifications which are authoritative and test-proven (e.g. barrier-free or accessibility standards)
- *Standard Detail:* A set of well-documented and repeatedly used high-resolution 2D Drawings. Standard Details may be generated out of BIM models or legacy CAD systems
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- *Model Component:* A virtual element representing a physical building object. Model Components may be parametrically driven, 2D or 3D, and may also represent abstract items (e.g. North Arrow).
- *Modelling Error:* Modelling errors are many types including: missing elements, wrong category of elements, lack of data within elements, unsuitable Level of Development, overlapping elements, wrong material, wrong position or orientation. Also refer to Error-Free Model, Model Validation and Model Quality.
- *Project BIM Manager:* A BIM Role played by an individual or an organization on behalf of the whole Project Team. The Project BIM Manager has many responsibilities (typically defined within the BIM Execution Plan) which include: BIM Facilitation, coordinating data-exchange activities, fulfilling pre- defined Design Specifications and Delivery Specifications, and overall Model Quality control.
- *Request for Information:* RFI is a process whereby a Project Participant (e.g. a contractor) sends a note to another participant (e.g. an architect) to confirm the interpretation of what is documented or to seek clarification of what is specified within a 2D Drawing or a BIM model.
- *Spatial Coordination:* A Model Use representing the utilization of BIM models to coordinate the placement of objects and account for their spatial requirements (e.g. access panels and keep-clear areas) within a 3D space. Also refer to Clash Avoidance and Clash Detection.
- *Standard:* Detailed set of product/service descriptions (prescriptive or performance-based) acting as a reference to be measured against. Standards typically denote a set of Specifications which are authoritative and test-proven (e.g. barrier-free or accessibility standards)
- *Standard Detail:* A set of well-documented and repeatedly used high-resolution 2D Drawings. Standard Details may be generated out of BIM models or legacy CAD systems.

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Government of India
Ministry of Housing & Urban Affairs
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