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BIM – CONSTRUCTION LIFECYCLE

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ABSTRACT

Engineering, construction, and architecture have all been impacted by building information modeling, or BIM. The use of BIM technology during a building's operational phase is only now beginning to gain popularity among building owners looking for creative ways to increase the effectiveness of their facility operations. Lifespan The process of creating, storing, and using building data to manage operations and maintenance of buildings over the course of their operational lives is known as building information modeling, or BIM.

Many facets of building operations that gain from improved data are of interest to facility managers. The goal is for stakeholders to produce and utilize consistent digital information at every stage of the asset's lifecycle. BIM Lifecycle is the process of creating, utilizing and maintaining the building information.

BIM technology has the potential to significantly increase the efficiency of project maintenance as well as building design, production, construction, operation, and maintenance. Specifically, information management throughout the manufacturing stage optimizes the production process, and collaborative design using BIM technology improves design efficiency. Its data management function increases the effectiveness of building operations and maintenance, and its 3D visualization tool lowers construction errors and encourages efficiency in the constructing phase.

Keywords: Life-Cycle Management, BIM (Application, Technology), Building Lifecycle, Digital Construction, Bim Collaboration, Cost Control

1. INTRODUCTION

Building information modeling, or BIM, is the process of digitally capturing a facility's physical and functional characteristics. It's a procedure that creates and maintains digital representations of locations' functional and physical attributes. These digital representations, known as BIM models, are more than just basic 3D visuals they hold extensive data that may be utilized for the life of a constructed environment. Throughout the design phase, BIM technology promotes collaborative design; in the production phase, it optimizes through information management; in the construction phase, its 3D visualization tool lowers errors and boosts productivity; and in the operation and maintenance phase, its data management feature improves building operation and maintenance efficiency.

Building Information Modelling allows for the creation of a virtual representation of a building or infrastructure project, which can be used throughout its entire life cycle. This virtual representation, also known as a BIM model, contains detailed information about the project's design, materials, cost estimates, scheduling, and maintenance procedures. By using BIM's visualization technology with 3D, 4D etc dimensions and large data, potential problems and risks can be rectified. This ultimately leads to better control over the project's quality, progress, and cost. It has been shown that using BIM in the construction industry can maximize resources, reduce costs, and expedite project planning. The purpose of this article is to examine and assess the challenges related to the construction industry's use of BIM as a digital information tool. Some potential barriers to adopting BIM construction industry include resistance to change from traditional practices, lack of awareness and understanding of BIM, limited investment in BIM technology and training, interoperability issues with existing software and systems, and the need for standardized practices and protocols. BIM can be used as a tool in various aspects of construction industry, including virtual construction, time-dependent control and maintenance management, and lifecycle management.

Building information modeling is an advanced 3D model-based technique that gives experts in the fields of engineering, construction, and architecture all the data they need to plan, design, and build infrastructure and structures. Both design and construction may work more productively and capture the data they generate along the process because of BIM. Project planning, resource allocation, and operations and maintenance tasks are all supported by this data. Although it can be applied to many different industries, BIM is most commonly used in the architecture industry. Throughout the course of the project, it facilitates better teamwork, enhances building performance, and aids in design decisions. In addition, structural engineering, civil engineering, construction, and MEP (mechanical, electrical, and plumbing) all use BIM.

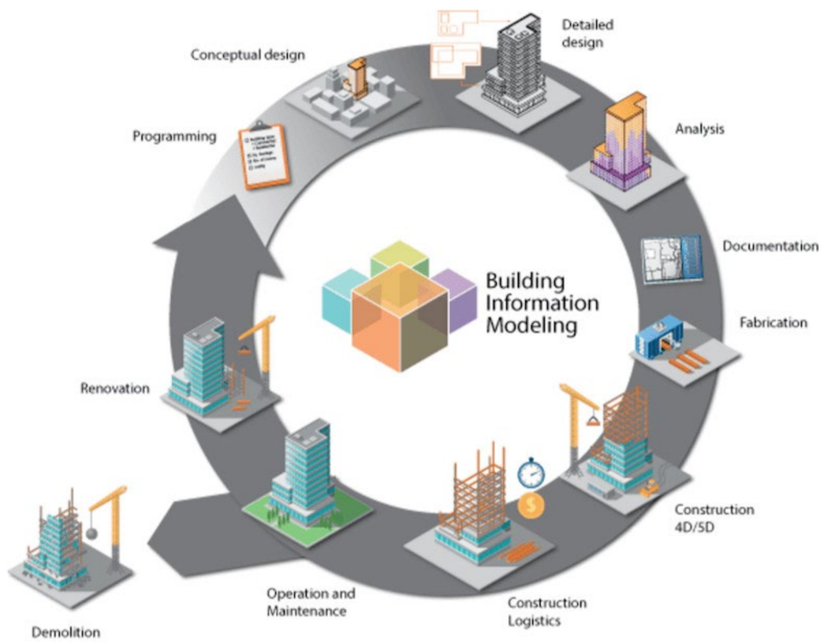

Figure 1: BIM Lifecycle

Constructing Information Models Life cycle management encompasses all stages of the process, including planning, designing, building, executing, operating, and dismantling. Digital techniques are then used to produce, maintain, and distribute the fundamental asset's information management model. Building Information Modeling (BIM) offers a digital depiction of a structure's functional and physical attributes, and it has revolutionized the construction industry. This study looks at how BIM enhances the construction lifecycle management process during the phases of design, construction, operation, and maintenance. A corporate strategy called life-cycle management (LCM) was created to manage a product or service's whole life cycle. Information about buildings should be recorded and used again during the course of their lifetime. Additionally, the value of information has been highlighted as a means of improving communication, leading to the emergence of effective construction information management as a factor in deciding the outcome of a multi-stakeholder project. Since almost all pertinent information for a facility is created throughout the design, shop drawing, fabrication, and construction phases, the life-cycle management of construction projects is thus not properly implemented in the construction company.

An overview of the construction lifecycle and the function of BIM at each stage is given at the outset of the article. It emphasizes how collaborative design is made easier by BIM, allowing interdisciplinary teams to collaborate easily, spot conflicts, and maximize building performance. Additionally, it covers how 4D and 5D modelling from BIM helps with on-site safety, subcontractor collaboration, and construction planning and scheduling. The article also looks at how BIM helps with facility management by giving precise and current information about building systems, equipment, and components. It examines how data analytics and building performance modelling, along with BIM-based facility management systems, may maximize space use, speed up maintenance procedures, and increase energy efficiency.

1.1. AIM AND OBJECTIVES

Aim: BIM for Construction Project Lifecycle: Advantages and Applications. To investigate the application and effectiveness of BIM across the construction project lifecycle. Improve coordination, planning, and preparation for construction activities. Streamline construction processes, enhance collaboration, and ensure quality control.

1.2. OBJECTIVES

Consider the possible advantages of using BIM for construction projects at every stage of the process, such as better project outcomes, cost savings, and more cooperation.

Determine the advantages and difficulties of adopting BIM during the construction life cycle.

Create accurate and detailed 3D models of the building design and resolve design conflicts and clashes before construction begins.

Generate accurate quantity take offs and cost estimates from the BIM model. Perform constructability reviews and identify potential issues or risks. Using the model as a guide, create comprehensive construction schedules and sequencing. By extracting accurate fabrication details, you may make prefabrication and modular building easier. Track progress and compare actual construction with the planned model (4D BIM). Integrate BIM with project management tools for efficient communication and documentation. As-built information for accurate record keeping.

Enhance energy analysis and sustainability monitoring throughout the building's lifecycle. Reduce errors, omissions, and rework, leading to cost savings. Ensure better quality control and adherence to project requirements. Facilitate sustainable design and construction practices.

2. METHODOLOGY

A systematic approach is necessary to use Building Information Modeling (BIM) across the construction project lifecycle. Planning and preparation that establish the project's BIM goals, objectives, and use cases. Create a BIM execution plan that outlines the procedures, roles, and responsibilities. Provide the project team with BIM standards, procedures, and guidelines. Establish a cooperative BIM setting for design teams, which include consultants, engineers, and architects. Collaboratively create the BIM model by adding structural, architectural, and ME plans. Utilizing the BIM model, carry out design reviews, clash identification, and design optimization. Generate accurate quantity take offs, cost estimates, and schedules from the model.

For constructability evaluations and risk or issue identification, use the BIM model. Using BIM data, create comprehensive construction timelines, phasing plans, and site logistics. By extracting fabrication information from the BIM model, you can make prefabrication and modular construction easier. Connect BIM to project management software will facilitate communication and cooperation. For on-site coordination, visualization, and progress tracking, use BIM models (4D BIM). In order to maintain correct records, capture and update as-built information in the BIM model. Use BIM to handle site logistics, safety planning, and quality control. Connect BIM to field technology (such as augmented reality and mobile devices) and construction management systems. Connect BIM to computerized maintenance management systems, Internet of Things devices, and building automation systems. Construction Project Lifecycle is a technological approach that aims to visualize and manage construction projects throughout their entire lifecycle.

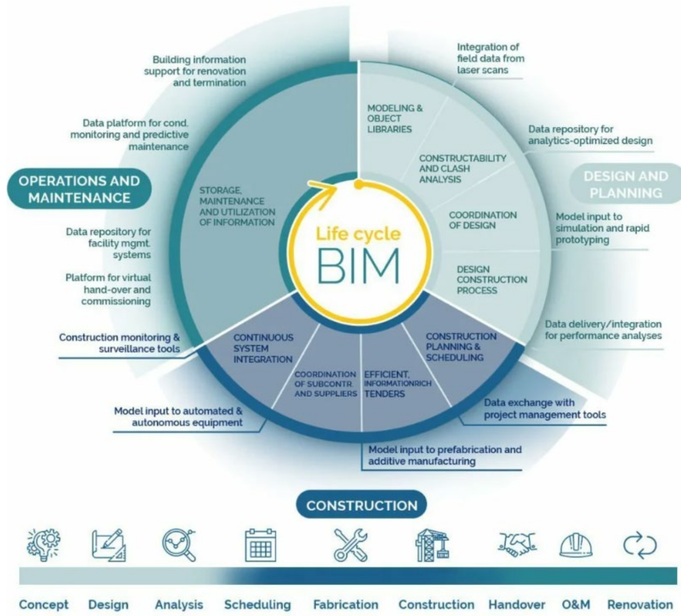

Figure 2: BIM Construction Lifecycle

The informational components of each Stage are described in this section.

2.1. PRE-DESIGN STAGE

Detailed site analysis and feasibility evaluations are made possible by the integration of geographical information system (GIS) data and current site conditions in BIM models, which are used for site analysis and feasibility studies. Examine the literature of BIM to pre-construction tasks like early planning, feasibility studies, and conceptual design. Examine the ways that BIM helps with pre-construction cooperation, visualization, and decision-making. Emphasize study results about the advantages and difficulties using BIM in pre-construction procedures. Designers can evaluate various site constraints, such as topography, existing structures, and environmental factors, to inform the initial design concept.

BIM models facilitate effective communication and visualization of project goals, helping to align stakeholder expectations and gather requirements more accurately. Virtual walkthroughs and simulations using BIM models can be used to gather feedback from stakeholders and refine project requirements. Conceptual design and massing studies, BIM tools allow designers to explore and iterate on conceptual design options, creating digital massing models to evaluate various design alternatives. Designers can analyze the massing options on factors such as building orientation, daylighting, and site integration. Project planning and scheduling can aid in developing preliminary project schedules and phasing plans, considering factors such as site logistics, construction sequencing, and resource allocation.

2.2. DESIGN STAGE

Using a shared digital model, the Collaborative Design Process facilitates real-time collaboration amongst consultants, engineers, architects, and other stakeholders. Teams can collaborate on the same model simultaneously, enhancing communication and collaboration. Authoring and Visualization of Designs Designers can produce intricate 3D models of the building, complete with structural, architectural, and MEP (mechanical, electrical, and plumbing) systems, using BIM software. Virtual walkthroughs and realistic visuals improve understanding and communication of design. Numerous investigations, including structural analyses, energy performance analyses, daylighting simulations, and sustainability assessments, are made easier by design analysis and simulations. Based on these assessments, designers can assess and refine their design options.

Clash Detection and Design Reviews Automatic clash detection identifies potential conflicts between building systems (e.g., architectural, structural, MEP) before construction. Virtual design reviews help identify and resolve issues early, minimizing costly rework and delays.

Cost Estimation and Quantity Take offs BIM models enable accurate quantity take offs and cost estimates directly from the digital model, supporting precise budgeting and cost control.

The interchange of design data in a standardized and structured manner, BIM helps project stakeholders communicate with each other more accurately. Throughout the design process, consistency and coordination are ensured by the tracking and management of design revisions and modifications inside the BIM environment. BIM facilitates sustainable design practices by enabling energy analysis, daylighting simulations, and material selection based on environmental impact assessments.

2.3. CONSTRUCTION STAGE

Construction Planning and Coordination: Detailed construction planning, scheduling, and sequencing are made possible by BIM models (4D BIM). It is possible for contractors to see how the construction is progressing, spot possible problems or disputes, and streamline the order of work. By facilitating cooperation between different trades and subcontractors, BIM reduces delays and rework. Site Logistics and Safety Planning BIM models can be used to plan site logistics, such as temporary facilities, material staging areas, and equipment layout. Safety hazards and potential risks can be mitigated through BIM-based safety planning. Visualization and Collaboration On-Site BIM models give construction crews a visual reference that helps them comprehend the building specifics and design purpose.

Monitoring of Construction Progress As-built data can be added to BIM models, allowing for progress tracking and comparison with the intended timetable and design. Any inconsistencies or departures from the model can be found and fixed. Modular construction and prefabrication Prefabricated components and modular construction methods are supported by the precise production specifications found in BIM models. By moving work off-site, this can increase construction efficiency, quality, and safety. Quality Control and Inspections When conducting quality control inspections, BIM models are used as a guide to make sure that construction standards and design specifications are followed. As-Built Recordkeeping As the project is being built, as-built information can be added to BIM models to provide an accurate digital depiction of the finished product.

2.4. OPERATIONS AND MAINTENANCE STAGE

BIM is essential. As a digital twin of the completed asset, the as-built BIM model is updated during the building phase and offers useful data and functionalities for facility management and maintenance tasks. Maintenance and Asset Management the BIM model includes comprehensive details on the systems, equipment, and building components, along with manufacturer information, specifications, and upkeep needs. BIM model can be used by facility managers to plan for equipment replacements, manage spare parts inventory, and establish and monitor preventive maintenance programs. For effective asset management, BIM makes it easier to integrate with computerized maintenance management systems.

Planning for efficient space management and usage is made possible by the precise spatial data and room information provided by BIM models. Using the BIM model, facility managers may forecast future space needs, optimize occupancy, and analyze how much space is used. Building automation systems and Internet of Things devices can be combined with BIM models to enable real-time monitoring of building systems and equipment performance. The BIM model allows for the visualization and analysis of data from BAS and IoT devices, facilitating the implementation of proactive maintenance and energy management measures. Energy Analysis and Sustainability BIM models can be used for ongoing energy analysis and performance simulations, supporting sustainable building operations and energy-efficiency initiatives. Facility managers can rectify areas for improvement and implement energy-saving measures based on the analysis results.

2.5. OVERALL PROJECT BENEFITS

BIM offers many advantages to building projects for Effective cooperation and communication between architects, engineers, contractors, and facility managers are made possible by BIM. The shared digital architecture facilitates easy data exchange and coordination by acting as a central repository for project data. Stakeholders are better able to comprehend and convey design intent and construction processes because to the detailed 3D visuals and virtual simulations that BIM models offer. The project, better decision-making is supported by this enhanced visualization. Efficiency and Productivity simplify workflows and procedures, cutting down on needless work and decreasing mistakes and rework. Across all project phases, productivity and efficiency are increased via automated clash detection, quantity take offs, and scheduling features. Better project cost control is supported by BIM, which makes precise cost estimation and budgeting possible from the outset of design. Early problem detection and resolution via BIM reduces construction delays and expensive rework. Compliance and Quality Assurance When conducting quality control inspections, BIM models are used as a guide to make sure that construction standards and design specifications are followed.

2.6. BIM CONSTRUCTION PROJECT LIFECYCLE

During building projects, building information modeling technology facilitates the creation of building data that is recorded on a highly collaborative platform and allows for more intelligent building management. This data, which also covers the environment, geometry, geography, costs, and materials, offers geographic analysis. This technique improves the control, planning, building, and designing efficiency.

2.7. BIM IN PROJECT LIFECYCLE WORK

To incorporate logical discoveries into real buildings, building information modeling is utilized. In order to create information that can be later combined into built forms, BIM uses CAD as a tool. This allows for more intelligent, dynamic, and visually appealing design. The "I" in BIM refers to "information-driven decision-making." Smart buildings are starting to take over the infrastructure space, therefore facility managers are keeping themselves busy by coming up with increasingly clever ways to monitor the development processes. This is the kind of situation where digitalization of building life cycles is necessary.

2.8. BIM CONSTRUCTION PROJECT LIFECYCLE

2.8.1. BENEFITS OF BIM FOR INFORMATION MANAGEMENT

Centralized Digital Repository BIM models serve as a centralized digital repository for all project information, including design data, construction documents, asset information, and maintenance records. This centralized approach streamlines information access, reduces redundancies, and minimizes the risk of data loss or fragmentation. Interoperability and data integration make it easier to integrate data from multiple software programs and sources that are used over the course of a project. Interoperability in BIM is made possible by open data standards and file formats, which facilitate smooth information sharing between systems and stakeholders.

BIM models ensure data consistency by maintaining a single source of truth for project information. Changes made to the model are automatically reflected across all related documents and drawings, minimizing coordination errors and discrepancies. Mobile devices and cloud-based platforms enable access to up-to-date project data from anywhere, improving collaboration and decision-making. BIM software can automatically generate various reports, schedules, and documentation directly from the model data. This automation reduces manual efforts, improves accuracy, and streamlines documentation processes.

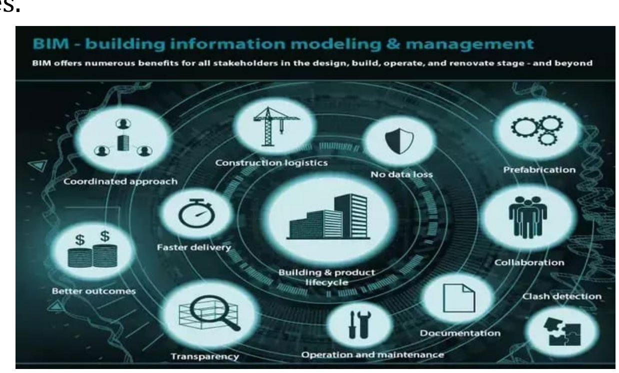

Figure 3: BIM Modeling & Management

2.9. BENEFITS OF BIM FOR FACILITY MANAGEMENT

Figure 4: BIM Facility Management

Large-scale project management and information maintenance become more complex. This is where BIM comes into play, helping to reduce the need for additional labour by streamlining information maintenance. By identifying energy alternatives to inefficient ones, facility managers can use BIM to put eco-friendly strategies into effect. Consequently, this improves the building's efficiency. Delivering precise data on the current project condition is made possible in part by BIM services. This expedites procedures and saves time and money on renovations.

2.10. BIM FACILITY MANAGEMENT

Total Cost of Ownership (TCO) related to operations and maintenance, BIM facilitates long-term data leverage. BIM is useful to record the costs on a balance sheet and to understand the costs when you see them as materials in built form. It is also useful for examining the expenses of a real-time building that is equipped with facilities and can resolve data as needed. BIM provides relevant information about critical systems and enables users to model the consequences of upgrades, maintenance, and repairs to systems. Combining space management software with a record system yields data-backed solutions. Contextual data points that are networked together underpin everything used in a building's ecosystem, including digital models and the Internet of Things (IoT). For instance, BIM generates digital twins of real buildings depending on variables like temperature and energy consumption.

Figure 5: BIM Facility Management Process

2.11. BIM INFORMATION MANAGEMENT CONSTRUCTION PROJECT LIFECYCLE

This methodology enhances services while lowering costs, risks, and time. Communication is further improved by the abundance of saved and repurposed building information. Improved construction information management facilitates effective stakeholder collaboration and successful project execution. In the end, this smooths out the wrinkles in information sharing that are typically present since there are insufficient effective venues for sharing information.

2.12. COMPONENTS THROUGHOUT A CONSTRUCTION PROJECT LIFECYCLE

2.12.1 DESIGN PHASE CONSTRUCTION PROJECT LIFECYCLE

Using a digital model, the client's construction ideas are presented throughout the design phase, along with the suggested functional requirements and project standards.

Publicly accessible project information; information about the projects; specifics about the proposed project's location; building and contract information; and economic data

2.12.2. CONSTRUCTION PHASE OF A CONSTRUCTION PROJECT LIFECYCLE

The dynamic process of managing and controlling construction ultimately expands the application of C-BIM. This is a drawn-out and intricate procedure involving owners, suppliers of materials and equipment, general contractors, subcontractors, and pertinent government departments.

Information about the project that is available to the public; general situation; technology; construction management; resource; environmental; and information about projects that are similar.

2.12.3. THE OPERATION PHASE OF A CONSTRUCTION PROJECT LIFECYCLE

Operation management provides a comfortable atmosphere for users while ensuring that building facilities function and reach sustainable uses.

Information on public safety and disaster preparedness; environmental information; building information; contract papers; record information; project situations; equipment information; economic information; building information; environmental information; public security and disaster protection information.

2.12.4. FLOW THROUGHOUT THE LIFECYCLE OF A CONSTRUCTION PROJECT

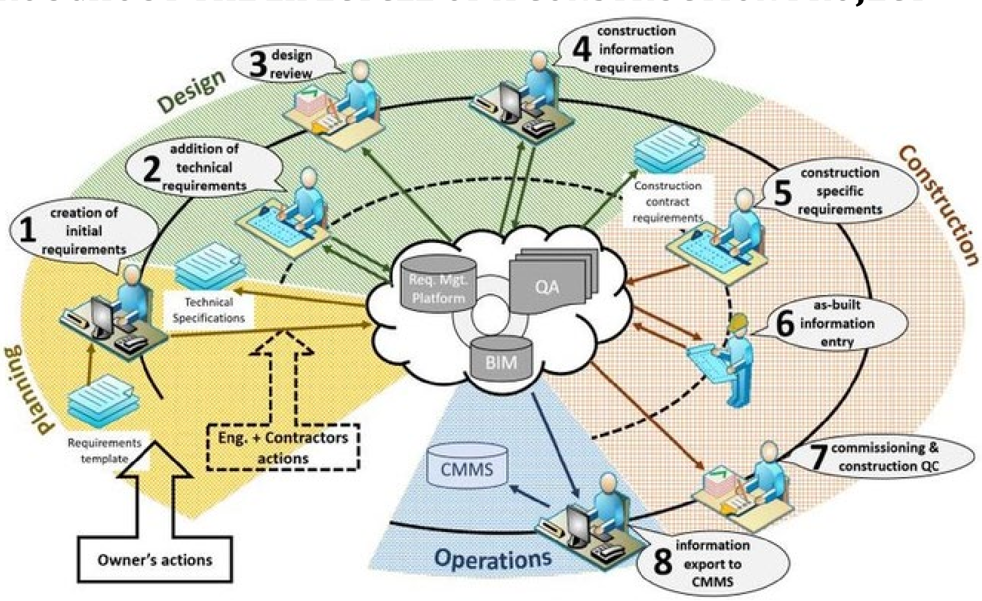

Figure 6: BIM Construction project Lifecycle

Data on various departments and components is constantly shared and updated on BIM systems, from the design stage to the operation phase. Consequently, teamwork and communication are accelerated.

2.12.5. DESIGN PROCESS FLOW

The design process is divided into three sections: structural, architectural, and facility engineering. The facility engineering design includes the design of the thermal power system, HVAC, electrical, drainage, and water supply systems.

2.12.6. CONSTRUCTION PROCESS FLOW

Four categories have been established for the architectural and structural engineering phases: foundation engineering, waterproof engineering, building decorative engineering, and main structure engineering.

2.12.7. BIM THROUGHOUT THE PROJECT LIFECYCLE

BIM is employed in building projects at various phases, with economic benefits included. However, BIM's potential for construction project lifecycle management is frequently overlooked. Accurate multidisciplinary modeling and better information activities including generation, retrieval, communication, and distribution are the main areas where BIM is helpful. The secondary benefit of BIM integration is increased material handling efficiency. BIM is a dependable source of information that helps decision-makers stay informed. It resembles a computerized data facility. There is more to the construction process than just planning and erecting buildings. Construction processes are more involved and take longer than one may think, from the time drawings are created on paper to the labour-intensive building process on the job site. Here, however, BIM steps in as our saviour, helping to streamline various phases of the building process and increase its effectiveness and accessibility. Using BIM improves several stages of the building process, including managing costly and hazardous equipment, working on large sites, and coordinating with contractors.

2.12.8. PLANNING AND DESIGN

Designing and planning are important processes in and of themselves, they are also seen as crucial steps in the construction process. When BIM is used, we can optimize them, boost their effectiveness, and avoid technical issues.

2.12.9. CONSTRUCTION

Substantially simplifies teamwork and communication amongst the different project stakeholders. Real-time monitoring of construction sites facilitates supplier collaboration. By enhancing the visual element of the construction activities, BIM helps to develop and guide them through the phases of construction.

2.12.10. OPERATIONS AND MAINTENANCE

Maintaining and running these structures is one of the final stages of construction, and this is where BIM helps to streamline post-construction procedures. By utilizing a digital twin that facilitates the assessment of materials, lifetime, installation dates, and other details, BIM adds value to cooperation and maintenance by assisting customers and facility managers in the operation of HVAC, MEP, and conflict resolution.

2.12.11. EFFECTS OF BIM ON DIFFERENT CONSTRUCTION PHASES

Over the course of their lifetime, construction projects go through three main phases: design (D), construction (C), and operations (O). The tasks, actions, and sub-activities that make up these phases are then further separated.

2.12.12. BIM MANAGEMENT CONSTRUCTION PROJECT LIFECYCLE

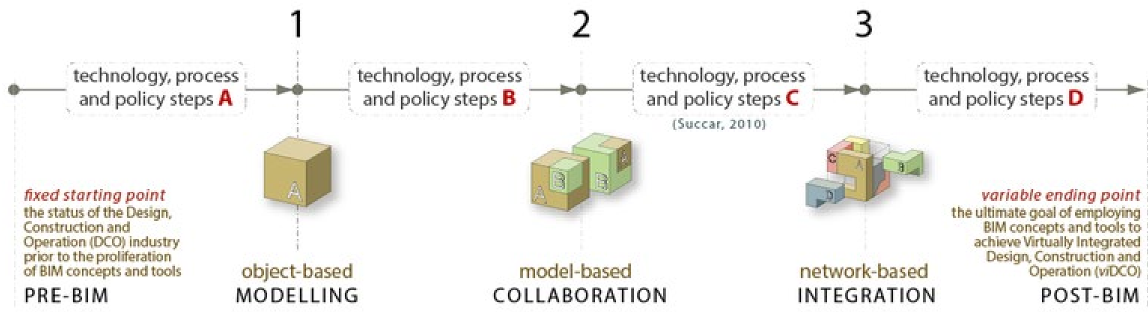

Figure 7: BIM Management Construction Project Lifecycle

BIM not only optimize different phases of a building project's lifespan, but also help with lifecycle management. As was previously said, these benefits include risk management, collaboration, and sustainability analysis for efficient operations.

Table 01: BIM Management Construction Project Lifecycle

Application	Function	Requirement
Collaboration	A forum for discussions between various software and parties involved	Comprehensive data from many stages, establishing a benchmark for regulations.
Reduce Risks	In a building process, keep an eye out for unfavourable incidents and concentrate on output.	Critical data from the present project and data from similar projects
Sustainability analysis	By examining the intricate building performance, concentrate on the sustainability aspect of the structure.	Information on the many stages required for cost analysis in addition to additional data for life-cycle assessment

3. CONCLUSION

BIM adoption has resulted in a huge digital change for the building industry. Building Information Modeling has become a potent methodology that is transforming the way construction projects are planned, carried out, and maintained. BIM provides several advantages and benefits to every stage of the project lifecycle, from original planning to design, construction, and operations. BIM makes it easier for stakeholders, engineers, and architects to collaborate on design processes during the design phase by allowing them to work simultaneously on a common digital model. By using simulations and visualizations, this method improves cooperation, lowers design conflicts, and facilitates well-informed decision-making. BIM helps ensure project viability and efficient execution throughout the pre-construction stage by supporting precise quantity take offs, cost estimations, and construction planning.

BIM models facilitate progress tracking, clash identification, and on-site collaboration. Construction sequencing and scheduling are streamlined by the incorporation of 4D BIM (3D model plus time), which increases productivity and efficiency. BIM also facilitates quality control, modular building, and prefabrication procedures, which eventually lowers rework and raises the standard of the project as a whole. These benefits include better teamwork and communication, better decision-making and visualization, higher output and efficiency, lower costs, better quality control, and the use of sustainable building techniques. Construction projects may overcome typical industry constraints and produce better-quality projects under budget and on schedule by implementing BIM. Construction projects can take use of digital technologies and integrated processes.

CONFLICT OF INTERESTS

None.

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None.

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