

Management of Green Building Projects using Building Information Modeling

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Abstract: Green Building Projects refers to process of building sustainable building for better living of human life. But nowadays due to increase in need to conserve resources and awareness of sustainability, Every Government Institution, Commercial companies, Residential Builder are preferring Green building due to various reasons like Government incentives, Better lifestyle etc. In order to encourage the construction of Green Building the IGBC (Indian green Building Council) is formed, which provides rating to guide the design of these Building and to ensure sustainability. The companies are showing interest to achieve the design based ratings provided by IGBC because they believe that Management based rating which is provided based on proper site planning, effective management of construction waste, Site pollution control, are not completely achievable. But the conventional management approach followed by the construction companies are totally invalid in case of green building projects. Since Green Building follows more detailed and innovative design and detailed planning to keep the cost and time on track, better use of resources, and conservation of environment during construction progress. Some reputed companies are doing green building projects not in efficient manner. This paper studies the complex management issues that are faced by the Company in handling the green building projects and provides solution using Building Information Modelling (BIM) which is simulation based management technique, which provides optimal solution to have better control over the green building projects. The paper also provides the simple and practical guidelines for implementing BIM in the construction firms for efficient delivery of Green building.

Keyword—Green Building, Building Information Modelling, IGBC.

1. INTRODUCTION

Green building is a method which is environmentally responsible, supports resource efficiency throughout the buildings life cycle: during design, construction, maintenance, renovation and demolition. Close cooperation of the design team, contractors, engineers, architects and the client throughout all the project stages is required for green building projects. Green building practice builds and advances upon the traditional methods of the classical building design method to take into consideration the economy, utility, design concerns, environment, natural surroundings, and comfort of the

inhabitants of that building. Green buildings are designed to reduce the overall impact of the built environment by reducing energy consumption, resources, waste, water and other resources more efficiently.

Although there are newly developed technologies to complement the current practices of the traditional building method, the above examples of the benefits green buildings provide should be sufficient enough for there to be a need to implement it into current and future construction projects. Green building is gaining importance nowadays and only, If it is fully understood it can be implemented properly. To do so, one must measure the benefits of the costs and amount of money saved throughout the lifecycle of the building as well as the amount of resources saved as well to fully realize the fruits this delivery method invokes. The whole intent of the green building delivery method is to provide an environmentally clean and healthy society which would utilize less of our limited building resources as well as natural resources so as to create a sustainable world. Sustainable development here means meeting the needs of the present without compromising the ability of future generations to meet their needs. Future generations will not have to worry about living in a time where resources might be scarce or might in turn not be available for them to thrive. Such valuable resources might be potable water, wood, a clean environment/healthy environment (reduced carbon emissions), etc. In order to bring the projects participants into a common platforms. A technically advanced management system must be present which provides the opportunity for every participants to organise their role in the projects and provides better communication among the individuals. The success of projects most rests in way of communication of issues by the site team and quick response to the issues by the Office team. The framework developed by the Tools of Building Information Modelling (BIM) can provide the solution for the issues and smoothen the communication between the projects professional who are involved in executions like Project manager, Planning Engineer, Quality and Safety Directors under the guidance of BIM manager to manage this software based framework.

2. METHODOLOGY

To serve the purpose of this paper, the observation is done to observe the management activities undertaken in a firm prior to executions and during execution in a reputed firm

in Indian which is familiar in undertaking Green Building projects and simultaneously a certain literatures are studied to gain knowledge about issues circulating design, management of green building projects, Building Information Modelling and recent advanced in BIM. And finally integrated management mechanism is developed which easily adoptable to Construction firms and feasibility of system is studied and concluded.

3. LITERATURE REVIEWED

Green Building are more challenging projects which includes higher cost, technical difficulties, Risks in contract, Unfamiliarity in execution, requires greater communication[1]. Based on the issues there is need for detailed planning of project with the end in mind before undertaking the tender or proceeding with execution of design [2]. Due to proper Pre-construction Planning of the projects risks associated with the projects can be forecasted and criticality of activities can be analysed in that way cost overruns can be controlled [3]. Use of Simulation based BIM software can effectively track cost and time of projects automatically which increase the process of pre-planning. These 4D system can provide software support can help to avoid schedule overlaps [4][5]. The system must be designed focusing on both design facilitation and BIM implementation. A project based learning environment for BIM must be created to learn outcomes in model communication, teamwork, critical thinking, problem-solving, and sustainability were conducted [7]. The Autodesk tools like AutoCAD, Revit, Navisworks, and Quantity Take-off can provide a simpler way of approach in a project [8]. The BIM can provide scope to practice concepts like Lean and operational research in green construction projects which is necessary.

4. ISSUES FACED IN GREEN BUILDING CONSTRUCTION

To provide this ideal future for our prospective generations, the people in charge at present with the construction and design processes should be taught the concept of building green. Currently, the green building construction industry is presented with issues in the various phases such as the predesign, design, construction, and post-occupancy phases. These issues are due to involvement of more sub-contractors than regular projects. So it has difficult for project management handle to effective handle different activities. The issues presented below are obtained through the literature reviews and an interview with an experienced construction professional. The issues contractors face during each phase of a construction project are as follows:

4.1 Pre-Design

- ✓ Participating in Design Charrettes can be time intensive

- ✓ Extensive collaboration with the design team, architects, team leader (AP)
- ✓ The fear of documentation being auditing

4.2 Design

- ✓ Identification of specifications for credits, i.e., SS, IEQ is unfavorable
- ✓ Climate sensitive green materials require more speculation during design when compared to their counterparts
- ✓ Increased time/participation is required to understand the scope of the design intents

4.3 Construction

- ✓ Perceived additional risk of dealing with unknown innovations
- ✓ More frequent construction inspections to ensure components are installed within the intent of the design team
- ✓ Restricts the equipment and materials they can buy, more expensive than conventional equipment
- ✓ Extra efforts to collect, store, and submit documentation

4.4 Post-Occupancy

- ✓ Contractor is tasked with providing new owner training for the equipment to be used
- ✓ Special green cleaning products are to be used to satisfy certain intents and credits.

Such issues reside in the fact that general Construction Management firms, contractors and subcontractors are not too fond of accepting of the high green building delivery method. Since most of the projects in these Indian firms are most driven based on the experience of the project manager and not by standard organisation methodologies. Whether it be the fact that this method of building requires more monetary assets and tends to cost more while providing more of a hassle, nonetheless there is still a perception of negativity in which further studies need to be performed to identify the main issues which tend to push contractors away from wanting to take on green building projects. Overall, there tends to be a higher association of responsibility and risk expected from general contractors and subcontractors when dealing with green building construction projects. Also, risk benefits such a competitive advantage through experience with green building projects must be in line with the end goal to be favourable by the general contractors and subcontractors to persuade them to pursue green building projects. Of course, thorough education and early planning as well as a perception of a social responsibility towards going green would help in the acceptance of such projects.

5. NECESSITIES FOR PROPER MANAGEMENT

Based on the issues observed from journals and company interviews. Their list of necessities which must be fulfilled in the management system of Design-Build firms, or contracting firm.

5.1 Design Knowledge

Since Green Building involves new innovative materials or customised use of regular materials in its progress. The planning professional must have certain design knowledge to know the importance of projects.

5.2 Pre-Construction Planning

To handle the Green Building and have a better control over projects execution. The Projects must planned in detail to identify the issues that are tend to arise during execution.

5.3 Tech- Support

Simulation based software support is required to pre visualise the projects which intern raises the confidence of the project approach team.

5.4 Quick Communication

Network based Communication must be established between the site team and office team. Green Building projects may involves customised use of regular materials, or use of new innovative materials in a proper ways. Which may increase issues during execution causing delays. In such cases quick clarification or solution must be provided by the design team to the execution team.

5.5 Safety Plan

In large green building projects which involves heavy use of machinery and labour. Proper safety planning must be done to avoid accidents during execution. The tech-based framework is required to forecast the safety issues that may arise during executions.

5.6 Quality Plan

QA/QC have major role in assuring whether design specification are met with project construction. They must be connected with Management team and design team to develop the projects with assured quality.

5.7 New Ideologies Implementation

When issues are arising day by day, the solution are developed by many research professionals theoretically. The developed management framework must have the scope the implement these principles to achieve between cost and time which are usual with green building projects in cost perspective.

6. BUILDING INFORMATION MODELLING

Building information modelling (BIM) is emerging as a new paradigm for improving productivity of construction projects. It is a technique for producing and controlling all information applied to various areas during the life cycle of structure. It functions in a simulation based computer platforms which provides greater efficiency in design and planning of construction projects. The development of cloud based environment for sharing and quick transfer of information provided scope for use of BIM in execution and control of construction projects. Autodesk is prime provider of all BIM based services like AutoCAD, Revit, Navisworks, Quantity Take-off, and BIM360 cloud. The implementation of BIM in an organisation requires a BIM execution plan which needs engineers with detailed software knowledge. But for quick implementation of BIM it requires an integrated methodology combining both traditional and advanced approach.

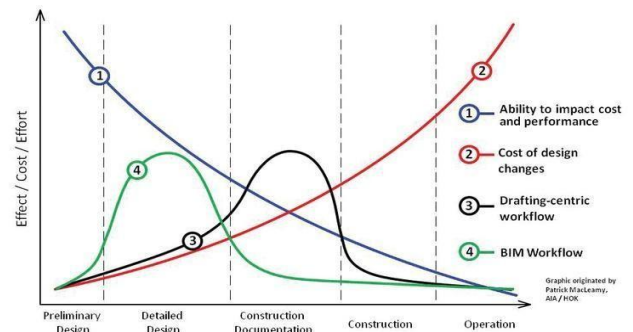


Fig -1: Macleany curve

The BIM software's used in this framework are as follows.

- 1) **AutoCAD:** It is 2D drafting software used to create plan drawings.
- 2) **Autodesk Revit:** It is simulation based BIM software which is used to create 3D models for Architecture, Structural, and MEP. The information can be programmed in to these models and energy analysis can be carried out.
- 3) **Autodesk Quantity Take-off:** It is estimation software used to create Bill of Quantity for the model created in Revit. It far more advanced to get quick cost data than regular MS excel.
- 4) **Microsoft Project:** It is a scheduling software which is used to detailed schedule with resource constraints. For handling multiple projects , Oracle Primavera is preferred,
- 5) **Autodesk Navisworks:** It is 4D modelling software where Revit model can be synced with MS projects schedule for the purpose of clash detection of different activities.

6) **Autodesk BIM 360 cloud:** It is cloud software to provide data exchange between the Autodesk BIM software. It also helps to provide better software communication between the office and site team.

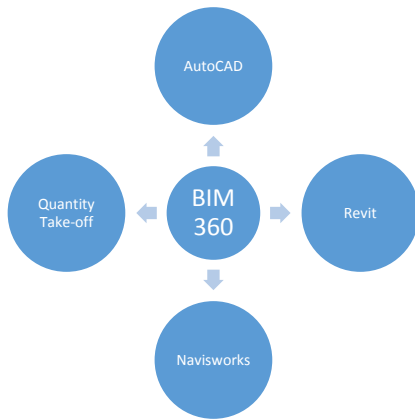


Fig-2: BIM 360 cloud

7. BIM BASED MANAGEMENT FRAMEWORK

The goal of this paper is to prepare the management framework comprising of organisational structure, Responsibility Matrix and complete Process Map with Information exchange to efficiently handle Green Building Projects throughout it lifecycle and ensure proper delivery

of the structures. To ensure proper control of the project, proper methodologies must be followed in all stages of the project. This system is designed for firm which undertakes Design Build Contracts and it can also customizable for Contracting Firms involved in Green Construction. The success of this framework lies in Collaboration, Coordination, Communication, Exchange, and Collation.

7.1 Design Approach

On projects is proposed by the owner to the firm. The management allocates a design coordinator who is having good knowledge in IGBC norms. As per order of the higher authority the conceptual design, checklist of credit points to be achieved in all designs is prepared and transferred the design team. He facilitates the design process in all stages such the required rating like Silver, Gold, or Platinum which has to achieve. The credit rating are provided in IGBC guidelines on the basis of features like Water Conservation, Energy Efficiency, Indoor Air quality, Sustainable Site planning, Proper Construction waste management. Once the Perfect Green Building design is achieved, it is provided to IGBC for Initial Certification. The final rating is given based on field inspection by IGBC professionals once project is completed. The design coordinator transfers design documents and Material related documents to the planning team and also guides the planning team in design related doubts which are tend to arise.

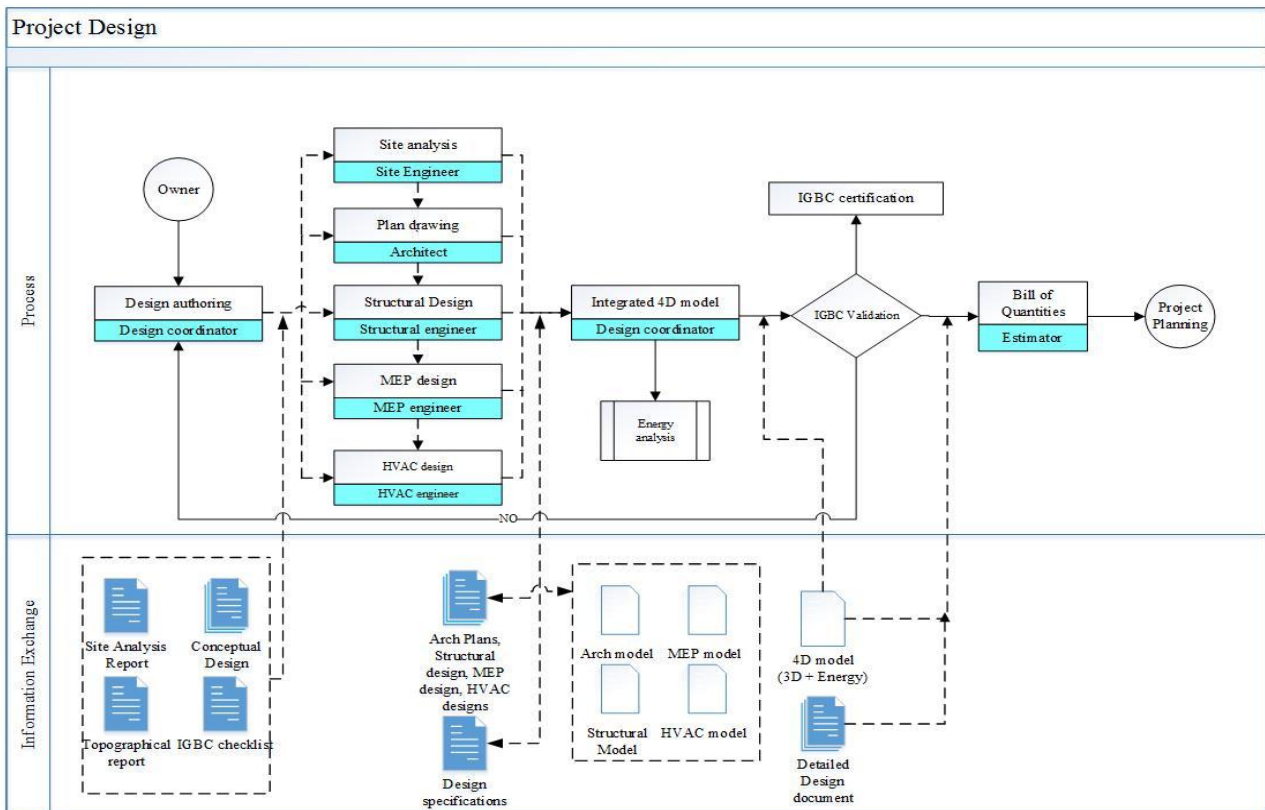


Fig -3: Green building design process

7.2 BIM integrated Execution planning:

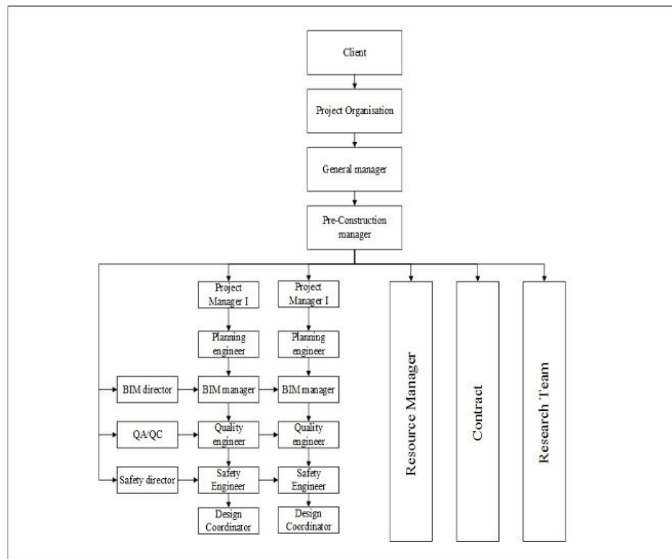


Fig -4: Organisational structure

Once the design documents are provided to the project manager of the projects. The projects manager assigns projects participants like Planning engineer, BIM manager, QA/QC, Safety director who are prime project participants and some common company professionals like Contract team to prepare contract documents in terms of tender projects, research team to provide suggestion to the planning team and Resource Manager to procure the resource required for the projects.

- a) **Planning Engineer-** Prime participants in charge of creating projects schedule and estimate the resource quantity require for each activity.
- b) **BIM engineer-** Incharge of authoring the model creation and clash detection through BIM software. He creates the 3D models for every activity and integrate with schedule for clash detection and notifies the Planning engineer in case change in schedules. Risk assessment is done under the supervision of the BIM manager using BIM softwares.
- c) **Safety director-** Incharge the planning the safety guidelines based the site location and activities to be carried out in the site. With help of BIM models the safety plan is created by the safety director.
- d) **QA/QC-** They are responsible to ensure whether the projects activity are completed without compromising the quality.
- e) **Resource Manager-** Once the Resource requirement is known. It is responsibility of the resource manager to procure the resource like man power, equipment required for the projects.
- f) **Research Team-** The research team provides suggestion to planning team based the latest theoretical management concepts. And provides new ideologies to achieve better efficiency in cost.
- g) **Contract team-** In case of contracting company, the contract team is required to prepare contract document with support of the planning team.

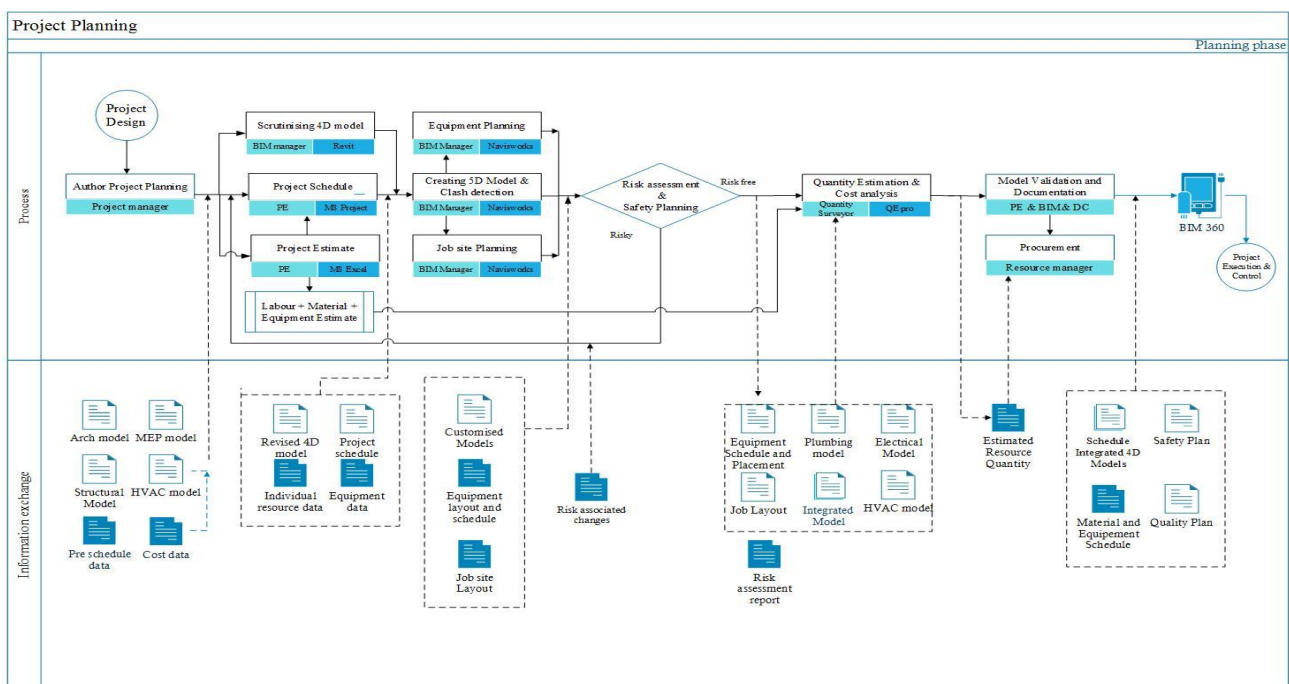


Fig -5: Planning process with information exchange

The Process map provides planning methodologies for the projects participants about their roles and jobs to be done. The detailed information exchange guidelines are also provided such that issues does not arise. The design coordinator is authorised to check whether the design norms are not compromised. The 4D model which is energy model integrated in scrutinized by the BIM manager and activity based 3D model is separated. The BIM manager also check the equipment placement and movement in the site and prepares the Job layout. Once the clash detection is done in Navisworks. The model is transferred to Risk Assessment team to analysis the execution related risk and approval is required. Once the activity is identified risky, the suggestion are provided to Planning Engineer and BIM manager to modify based risk analysis report. And process is repeated. If the plan is attested risk free or controllable risk, it is transferred the quantity surveyor for quantity estimation based the estimation data. Then the final execution model for the site management and documentation are validated by the Planning Engineer, Design Coordinator and BIM manager. And model and drawing are transferred to Autodesk BIM 360. And access is provided to the site team.

In case of contracting projects, based on the planning team reports the contract team prepares the documents for the tendering process provides guidelines for bid preparation.

The hypothetical data on the risk assessment reports is also mentioned in the contract for contractor safe site. The planning prepares two types of estimates for tender for

normal price based on the regular process. For lower price the Research team guidelines are considered and normal schedule is optimised to it and lower bid price is achieved.

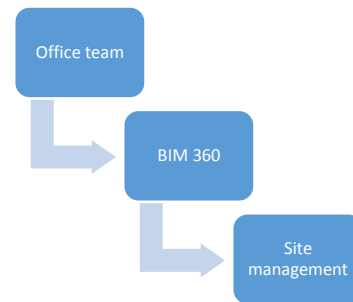


Fig -6: Communication

Throughout the planning the responsibility of the participants which has to be assigned are provided in the responsibility matrix.

R- Responsible

A- Approval Required

N- Must be notified

C- Must be consulted

S- Support required

S.no	WBS	Project manager	Planning team		BIM team			Consultants			R & D	Contract
			Scheduling (MS project)	Estimation (QE pro or excel)	3D modeling (Revit)	4d Model (Navisworks)	Risk assessment	Design	Safety	Resource Manager		
1	Project Initiation	R										
2	Project Design stage	C						R				
3	Project Planning stage	R						C				
	Project requirements	R						C				
	Preparing Project schedule		R							C		
	Preparing cost estimate		C	R						C		
	Activity based 3D model		C		R							
	Clash detection		S	N	S	R		C				
	Risk assesemt						R		A			C
	Preparing Project deliverables	N		R				A	A			
	BIM execution plan development					R					S	
	Preparing BIM based deliverables	N		S		R		A	A			
	Safety Plan					S			R			
	Preparing tender document						S				S	R
4	Tender stage											R
5	Project Execution stage	R		S		S		C	R			
	Procurement									R		
	Job layout	R			S	S						
	Project development	R		S		S		C	S	S	S	
	Progress Updating and tracking			R		S						
	Project meeting			R		S		A	C			
	Digital documentation					R						
6	Project closure	R		A		A		A	A	A		

Fig- 7: Responsibility Matrix

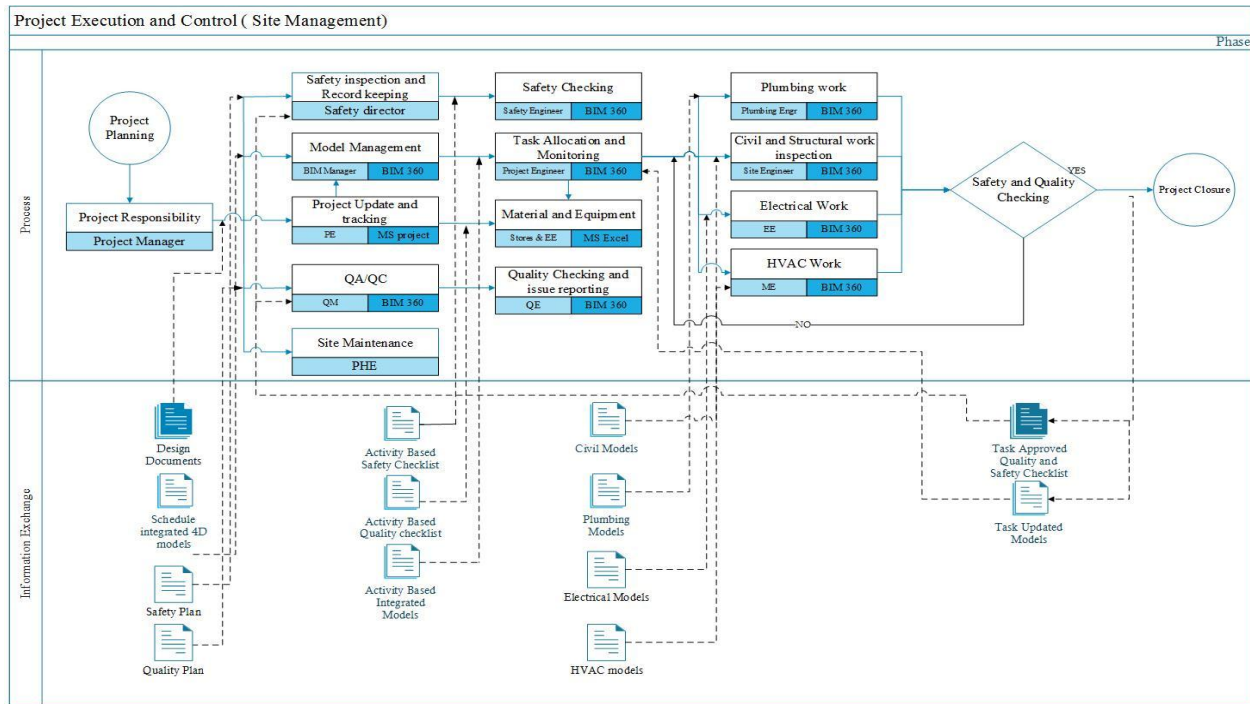


Fig -8: Construction and Closure

7.3 Construction and Closure:

In BIM integrated execution, every project site engineer must be provided with iPad or Tab which can provided access model and drawing in BIM 360 cloud. The projects participants like Planning Engineer, BIM manager can perform task allocation to every site engineer like Civil works, Electrical, Plumbing, and HVAC through network. The Site engineer can ask for clarification to office team or design coordinator through BIM 360 through mark up. In vice versa, the design team and planning team can notify any alteration in the process quickly through BIM 360. The Office team can know about the happening at site and be updated. The communication of issues and solution between engineers and management professionals can be quick which increases the confidence for the project authorities to balance between cost and time.

8. RESULTS AND DISCUSSION

The management framework designed with help of tools in Building information Modelling is suitable to achieve better site planning and execution so that execution based IGBC credit points can be achieved by the Indian companies. This management framework is framed to execute green design in a proper way better control over cost and time. It also provides idea the current project team player to use BIM to effectively handle Green Building projects in a better way without causing harms to society and achieving a better control over the projects in all stages. Further the latest innovation like Visual Reality, Augmented Reality can also be integrated with BIM for better approach on green building projects.

9. CONCLUSION

Most of the green building projects are facing issues mainly due improper communication medium between the office and site team. And also due to improper or lack of pre planning and risk assessment. All these are due lack proper computer based working platforms. Which is solved using Building Information Modelling in this paper. It suggested simple use of BIM for the projects and how it can be used in an integrated manner with current management approach. On further improvement of BIM based management system with visual reality and augmented reality it can provide ways to implement new construction technology like 3D printing to come into practice easily.

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