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# An Execution of Building Information Modelling for Factories and Warehouse Projects Construction in India – ETO India

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***Abstract—*** *Building information modelling is one of the most promising breakthroughs in the architectural, engineering, and construction (AEC) business (BIM). BIM technology generates a precise digital depiction of a building. When completed, the computer-generated model will have exact geometry and vital data to aid in the design, manufacture, and procurement of the structure. Many of the functions necessary to model a building's lifetime are also accommodated by BIM, setting the framework for new construction capabilities as well as changes in project team duties and interactions. BIM, when utilised properly, enables a more collaborative and errorless design and construction process, resulting in higher-quality buildings at lower costs and shorter project schedules. This chapter begins with an examination of existing building procedures and the inefficiencies they involve. It then describes the technology underpinning BIM as well as how to properly employ the new business processes it provides throughout the lifespan of a building. It concludes with a review of the many challenges that may develop throughout the transition to BIM technology.*

**Keyword:** Building Information Modeling, Revit, AEC Industry, BIM, Digital Modeling, Digital Construction, VDC, Augmented Reality.

## 1. INTRODUCTION

A key issue throughout the building process is a lack of coordination across varied professional backgrounds among construction stakeholders and other relevant parties. Rapid technology improvements, along with severe rivalry in the construction market for improved services, have sparked a fundamental shift toward the use of new approaches in the building sector. BIM creates a machine-readable digital representation of Industrial shade data to improve design, construction, and operation processes, as well as to improve Industrial shade lifecycle functions. Despite technological developments, industry adoption of BIM remains limited due to the risks and obstacles involved with this transition. Sustainable construction development is a worldwide issue.

Various concepts and methods to environmental challenges have been created over the last decades, including green Industrial shade certification (GBC) and Industrial shade information modelling (BIM).

However, in order to drive more innovation and optimize the process, an integrated approach is essential. Green Industrial shade accreditation encourages the use of green Industrial shade concepts. This new initiative intends to enhance the purchase of environmentally friendly industrial shades or infrastructure.

### 1.1. BIM in construction industry

BIM helps owners improve Industrial shade performance, decrease financial risks, shorten project timelines, acquire reliable and precise cost estimates, verify programme compliance, and optimize facility administration and maintenance. BIM increases Industrial shade design, analysis, simulation, and checking from the standpoint of an architect, and so offers a foundation for developing a better conceptual design, consistent construction documentation, and integration and communication among disciplines. BIM applications for contractors include constructability analysis and conflict detection, quantity take-off and cost estimation, construction planning and controlling, offsite fabrication, and streamlined handover and commissioning.

### 1.2 Clash Detection

Clash detection is the basic need of every multidisciplinary project in which a composite design must be evaluated for conflicts. Clash Detection is a way of evaluating and recognizing numerous interferences that usually occur throughout the coordinating process of 3D models developed in various current software applications such as Revit Architectural, Revit Structural, and Revit MEP. 3D models for various sorts such as structural, civil, and architectural &MEP are used in BIM (Mechanical, Electrical and Plumbing). When all of these different types of models are combined to create a complete BIM model, there is a chance that these elements will clash; in clash detection test, it detects the clashes or mismatches between different elements within 3D Industrial shade Information Model before actual construction begins, and thus time optimization in the construction schedule, cost reduction, and change orders. Increase the efficiency of design and construction projects by employing collision detection applications in the AEC sector.

### 1.3 Need of Clash Detection

Organizations prepare for the execution stage by arranging contracts with contractors, purchasing supplies, guaranteeing proper coordination and assembly order of the various systems of a project. When the contractor receives the design drawings and everyone is on-site and working, the most disputes are discovered. It compares two-dimensional designs to detect conflict disputes between specialist designs. Because specialty contributors, such as structural engineers and MEP engineers, draught their ideas separately, it is easy to spot incompatibilities when comparing these designs on distinct drawings. Contractors must ensure that structural elements, plumbing, electrical lines, and other components are properly detailed. If one of these clashes results in a change order, the consequences include project delays, design changes, material costs, and budget overruns. Using BIM and the Clash Detection program, possible problems to discovered in design or initial phases of engineering in the design process and rectified with more effective methods before construction begins.

## 2. OBJECTIVES

Revit Architecture software was used to generate a 3D model of the apartment's architecture for this project. Revit Structure software was used to design the structural details for this Industrial shade, while Revit MEP software was used to create the MEP (Mechanical, Electrical, and Plumbing) services. And Microsoft Project had handled the schedule (MSP). The architectural, structural, and service models were integrated into Navisworks software to discover conflicts between disciplines. The conflicts were found and handled, and the 3D BIM model was updated to reflect these resolutions. Finally, quantity analysis was performed on this model before and after collision detection.

[1] To create a Analyze Accuracy in Budget Planning along with 4D & 5D depiction of the Industrial project construction.

[2] To Reduce rework by implementing adequate coordination, which results in cost and time savings.

[3] To provide a standardized and streamlined approach for the conflict detection process.

## 3. LITERATURE SURVEY

**"An Implementation of Building Information Modelling for Industrial Projects Construction in India – ETO India":** IJIRSET, Volume 11, Issue 2, February 2022 Mr. Manoj Bhimalli, Prof. A. N. Bhirud

One of the most promising advances in the architectural, engineering, and construction (AEC) industry is building information modelling (BIM). BIM innovation makes a carefully made correct virtual representation of a building. When wrapped up, the computer-generated demonstrate will incorporate exact geometry and critical information to assist the building's development, fabricating, and obtainment exercises. BIM moreover obliges numerous of the assignments required to show a building's lifecycle, laying the base work for modern development capabilities as well as changes in extend group duties and connections. When utilized accurately, BIM permits for a more coordinates plan and development handle, coming about in higher- quality buildings at costs viable and shorter extend timelines. This chapter opens with a dialog of current development forms, as well as the wasteful aspects that these hones involve. It at that point goes on to portray the innovation fundamental BIM as well as how to successfully take utilize of the modern commerce forms it offers all through a building's entire lifecycle. It wraps up with a dialog of the various issues which will emerge whereas transitioning to BIM innovation.

**A review of tertiary BIM education for advanced engineering communication with visualization:** Badrinath, Amarnath Chegu, Yun-Tsui Chang, and Shang-Hsien Hsieh.

Presently a day, the engineering, designing and development with an operation (AECO) industry is persuaded to utilize graduates taught approximately Building Data Modeling (BIM) instruments, procedures, and forms, which offer assistance them to superior collaborative visuals and information and data into their ventures. In line with today's AECO industry necessities and government venture prerequisites, all-inclusive dynamic BIM specialists and analysts are planning BIM educating workflow and syllabus, educational program and courses. These educationalists and analysts are moreover creating arrangements to the impediments confronted amid integration of BIM instruction into mainland instruction frameworks (TESs). Be that as it may, BIM analysts have taken few endeavors as of late to supply a diagram of the level of BIM instruction over the world through audit and investigation of the most recent distributions related with BIM instruction in TESs. Consequently, this ponders endeavors to fill this crevice by giving an audit of the endeavors of around the world dynamic instructors and specialists and analysts to teach AECO understudies approximately BIM within the setting of progressed innovative instruction with visualization.

**A Preliminary Study on BIM Enabled Design Warning Analysis in T3A Terminal of Chongqing Jiangbei International Airport:** Amarnath Chegu Badrinath1 , Yun-Tsui Chang2 , Emerson Lin3 , Shang-Hsien Hsieh4 & Bin Zhao5

Integrated design collaboration is one of the important focus areas in the design phase of an Architecture, Building, engineering development & Operation (AECO) venture life cycle. Jumbled or no connect disciplinary checks may cause development mistakes, revamps, fabric wastage, extra alter orders, time, taken a toll overwhelms and so on. Subsequently, it is crucial to diminish the plan notices and improve the plan conveyance handle inside the AECO extend life cycle. As of late, Building Data Modeling (BIM) is considered as the one-of-a-kind and alluring apparatus, procedure and handle for progressing the plan conveyance prepare by worldwide AECO industry. Analysts within the past have endeavored BIM empowered plan caution investigation but less consideration was drawn towards proactive rectify modeling methods, i.e. on how to re-use the collected information for lessening the plan coordination issues in up and coming plans. In this investigate, we attempted a preparatory ponder on BIM empowered plan blunders investigation. This think about center on the BIM utilization inside the T3A terminal plan improvement and integration handle (Development timeline: 2012-2016) to move forward the T3B terminal plan conveyance handle (development time: 2016-20). Yield from this consider can be utilized for helping the plan groups, i.e. 2D CAD & BIM groups related with Chongqing Jiangbei Worldwide Airplane terminal venture, to make strides their efficiency and their organizational BIM usage.

**BIM IMPLEMENTATION IN DESIGN FIRMS. RISK-RESPONSE STRATEGIES TO SUPPORT CHANGE MANAGEMENT**

41St IAHS WORLD CONGRESS, Sustainability and Innovation for the Future 16th September 2016Albufeira, Algarve, Portugal

This paper presents a inquire about extend which is being carried out at Politecnico di Milano approximately the subject of BIM usage in plan firms. The in general development industry is confronting a transformation approximately innovation & information and system setup administration. Building Data Displaying (BIM) is both the innovation and strategy obtaining this alter. Indeed, in spite of the fact that benefits inferred from an sufficient information and handle administration by utilizing BIM are profoundly recognized and the innovation is quickly developing, the pace of BIM selection within the Italian setting is still moderate. The alter prepare includes various challenges and many risks components, interrelated to obstructions to overcome, got to be overseen: 1) Administrative: adjust and onetime obtainment and PLM; 2) Social/cultural: Challenge in appropriation of unused innovation and tall rate of Little and Medium Undertakings (SMEs); 3) Specialized: ineffectual synchronization among the distinctive program; 4) Organization: need of government back as well as national benchmarks and rules; 5) Prudent: tall venture prerequisites. Until presently, numerous inquire about endeavors have been concentrated on benefits, hence handle yields, determining from BIM Usage - instep, small intrigued has been set in mapping BIM inputs. The inquire about extend points to fill up this crevice by overseeing BIM execution in plan firms through the advancement of risk-response methodologies. This investigate venture, which is still progressing, is being conducted in two stages. The primary one in which the conventional plan handle has been broken down in phases and exercises, distinguishing, for each of them, yields and included partners.

**RESEARCH ON BUILDING INFORMATION MODEL (BIM) TECHNOLOGY:** Tianqi Yang1* and Lihui Liao

In this paper we may take a logical definition of the BIM; portrays the BIM six most successful and specialized characteristics; pointed out the pith of BIM innovation; the paper puts forward nine develop BIM innovation standard BIM innovation; portrays the improvement apparatuses and execution achievability of the specialized course of other innovation integration and advancement; to appear the development of BIM life cycle administration procedures and strategies based on two measurements; from subjective and quantitative BIM innovation and vitality utilization examination instruments are illustrations of advantageous combination; to center consideration on the focal points of BIM innovation, cleverly green and feasible plan issues; expansion of related innovation for direction and dialog; at last, the application prospect of BIM innovation in China Designing hone is talked about. At display, from the by and large point of view, improvement and application of building data show (BIM) innovation begins late in our nation, development strategies, the scale isn't idealize, framework and innovation arrangement, laws and directions framework has however to be set up; localization of single key specialized saves and coordinates specialized framework of building a body of inquire about and application are required to advance extend, the concept of BIM plan needs encourage direction, Bim and mechanical participation and trade at domestic and overseas to be in full swing, the popularization and application of BIM Technology, still ought to reinforce the purposeful publicity, energetically bolster, effectively advance. I stand within the enormous information, cloud computing data unused time and cleverly society cusp, bear BIM Innovation dispersal, enablers verifiable mission.

## 4. PROBLEM STATEMENT

To determine the applications and benefits of BIM, the industrial shade, at Dodballapur industrial area in north Bangalore shed project was chosen. Having mezzanine floor for office usage, and 1 shed has 2 parts with different temperature one is ambient, and one is 18 degrees centigrade. The facility getting used for automobile parts manufacturing for German automobile company. Building has planned and constructed with using 3d model and Construction documentation was extracted from 3d model and other details regarding the construction project are provided below.

### 4.1 DATA COLLECTION –

1. **Name of Construction Company:** FSIPL, Pune.
2. **Location of the Project:** KAIDB, Dodballapur, Banglore.
3. **GMAP –** Lat: Long: 13.260774977662916, 77.5644935979936
4. **Industrial shade Type:** Industrial shade
5. **Number of Stories:** PEB with Utility Area.
6. **Number of Phases 1**
7. **Name of the Project Head:** Mr. Aniruddha Kshirsagar
8. **Created Project Charter –** Scope of Project, Baseline Schedule, Communication Matrix, Conceptual Project development plan. Existing Site Condition, Possible risk assessment.
9. **Software Usage –** Sketchup, Revit, Navisworks, MS Project, MS Office, BIM 360.

Fig 1 FSIPL, Pune

## 5. RESEARCH METHODOLOGY –

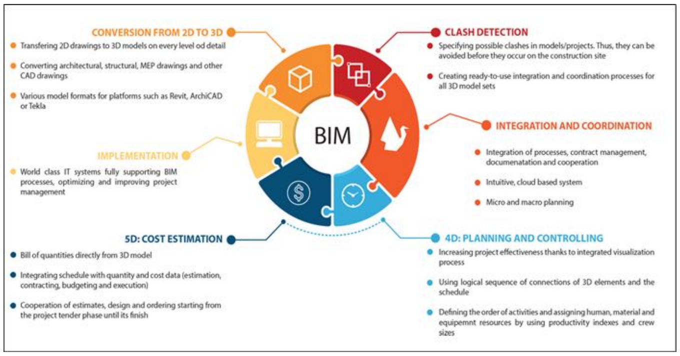
The BIM strategy looks for to coordinated forms and experts included in designing assignments by working on stages with facilitated and brilliantly 3D virtual models. BIM has incredible potential for basic building companies (SEC) and tackles their most striking issues.

Basically, in BIM implementation project phases are similar – like Initiation, Planning, Execution, Monitoring & controlling, Closure for Engineering development. Afterall this engineering process we use that model for different BIM uses.

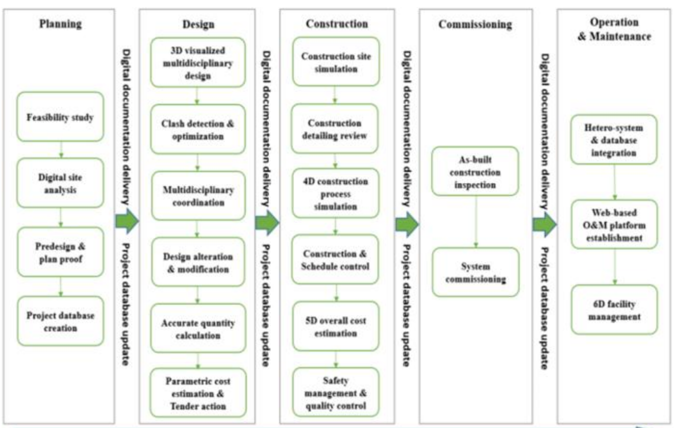
Below mentioned work flow followed from start to end of this Project.

1. Creation of 2D and 3D (Conceptual & BIM)
2. Clash Detection
3. Integration & Coordination

4. 4D Planning & controlling
5. 5D Cost Estimation
6. Implementation for different BIM uses (Construction Usage)




### 5.1 Detailed method BIM project for execution




## 6. ANALYSIS

BIM has an excellent visualization tool. It represented the Industrial shade in three dimensions (3D). The construction manager will give renderings, walkthroughs, estimating, and sequencing of the model during the Industrial shade phase of the project to better express the notion of BIM in 3D perspective. Visualization improves comprehension of the finished output of Industrial shadow. It detracts from the process of pulling together several standard 2D views to produce the intricacies of a 3D image. One of the most fundamental applications of BIM is the use of 3D modelling to produce a depiction of the structure. The designs are made in three dimensions, which adds perspective of Industrial shadow to the picture as well as the ability to exhibit numerous viewpoints and angles. When compared to two-dimensional graphics, this delivers greater clarity and ease of use. BIM software generates 3D models, albeit the LOD in each model varies.

Building Data Modeling is the source of computerized change within the AEC industry. The method of BIM usage empowers real-time collaboration and plan modifications for minimizing superfluous issues among the partners. Excelize encourages Engineering, Building and Development clients in creating the idealize BIM workflow in all ventures.

Fig 2 AutoCAD Plan

Fig 3 Modeling in Sketchup

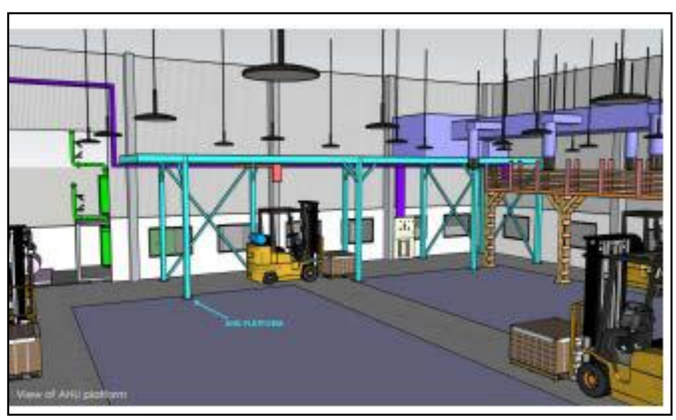


Fig 4 Detailing in Sketchup

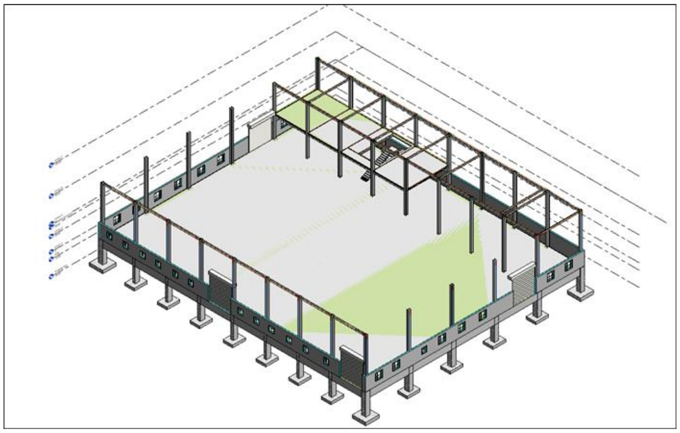


Fig 5 Detailing in Revit

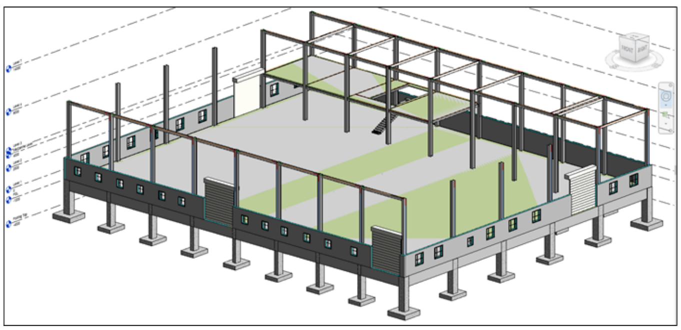
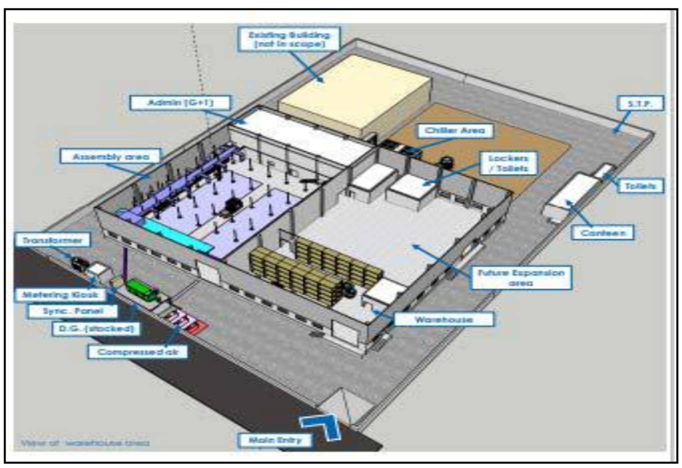


Fig 6 Detailing in Revit




## 6.1 Analysis - ETO Project – Baseline Plan

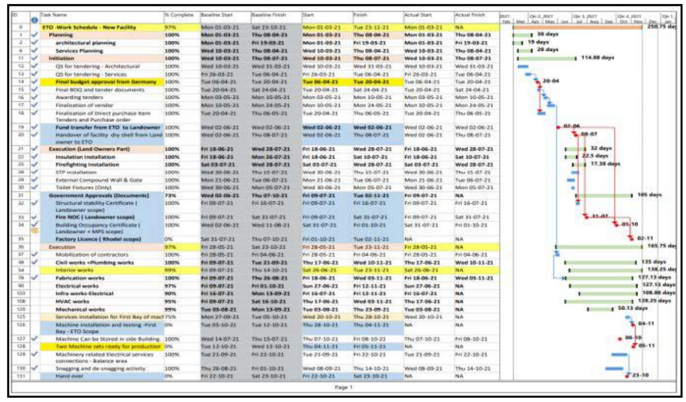
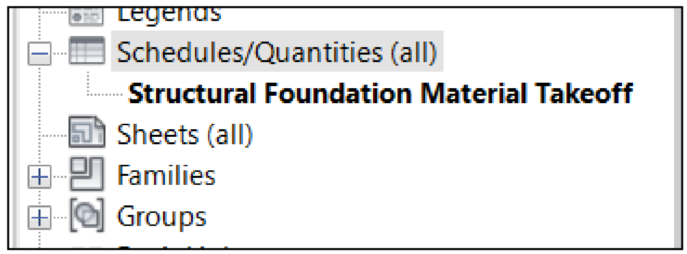
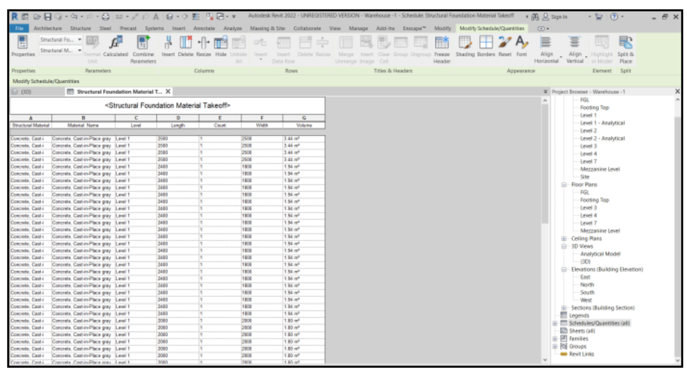


Fig 6 Baseline VS Actual Track in MS Project

## 6.2 Material Take off -



{3D} | Structural Foundation Material T...

<Structural Foundation Material Takeoff>

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Structural Material | Material: Name | Level | Length | Count | Width | Volume |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2500 | 1 | 2500 | 3.44 m³ |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2500 | 1 | 2500 | 3.44 m³ |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2500 | 1 | 2500 | 3.44 m³ |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2500 | 1 | 2500 | 3.44 m³ |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2400 | 1 | 1800 | 1.94 m³ |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2400 | 1 | 1800 | 1.94 m³ |
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| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2400 | 1 | 1800 | 1.94 m³ |
| Concrete, Cast-i | Concrete, Cast-in-Place gray | Level 1 | 2400 | 1 | 1800 | 1.94 m³ |

## 7. RESULT & DISCUSSION

- **Cost savings: -** Diminish human mistakes that can lead to extend delays as well as dreary or re-examined documentation. Moreover, we might control the modifications.

- **More Efficient / Effective Projects Engineering & designing -** By utilizing BIM, designers can begin planning the building early, which implies development can moreover take put early. Improved workflow moreover speeds up the method as each group part is working from the same set of models. • For case, an designer might choose to have certain parts of the extend pre-assembled in bulk utilizing mechanical autonomy. This permits the development group to simply secure the pieces in put when they arrive on location which spares a part of time.

- **Improved Communications -** BIM moves forward communication between all parties included in a venture counting temporary workers, originators, clients, and designers who all play a imperative part within the process. The reason for this is often since BIM depends on a 'single source of truth' which implies each piece of data relating to costs, models, and plan notes are put away and available from a central area. This gives everybody with full perceivability of the venture and guarantees they are working in couple. It's a true form of collaboration that makes a difference to dispose of any miscommunication so that all parties can discover the leading arrangement.

- **Faster and Easier Prefabrication and Modular Construction-** By utilizing BIM computer program, you'll make nitty gritty generation models that can at that point be pre-fabricated off location. By planning, enumerating, and building pieces off site in a controlled environment you'll be able progress productivity while diminishing squander, work, and fabric costs. This too spares you and your group important time as these segments can effectively be collected. As well as, modelers have more openings to plan secluded pieces of engineering that can be fitted together and incorporate complex resistance calculations. This spares temporary workers time and assets on location as they are not building pieces from scratch.

- **High Quality Results –** It made strides Extend plan exactness with regard to Budget arranging, blunder free Development documentation, incline communication, tends to less wastage in development stage since we have advanced show some time recently progressing to begin real development execution.

## 8. CONCLUSION

- Especially during building and renovation phases, dynamic updates empower real-time insights about a building. If you change X variable in a BIM plan, it updates Y and Z affected systems, to show a true-to-form model of what those changes look like and what they mean for facilities as whole. This intuitive action-reaction relationship cuts down on the guesswork of modifying facilities.

- Using collision detection algorithms helps to reduce coordination errors and human errors, resulting in excellent model accuracy. As a consequence, re-building will be avoided.

- Navisworks customers should first set up the components or items that they wish to compare during collision detection under the Batch tab before starting with a conflict test.

- Navisworks users may accomplish this by heading to the conflict detective tool and selecting the Batch tab. One of the most important tasks for Navisworks users is to detect and arrange disagreements based on commonalities.

- When AEC professionals in construction are placed together based on their potential to cause barriers, it is simpler for them to grasp the nature of conflicts.

- Using BIM technology reduced the total cost of the project throughout the building stage by assisting in the successful identification, inspection, and reporting of a project model.

## 9. REFERENCES –

[1] "An Implementation of Building Information Modelling for Industrial Projects Construction in India – ETO India": IJIRSET, Volume 11, Issue 2, February 2022 Mr. Manoj Bhimalli, Prof. A. N. Bhirud

[2] BIM IMPLEMENTATION IN DESIGN FIRMS. RISK-RESPONSESTRATEGIES TO SUPPORT CHANGE MANAGEMENT: Marcella Bonanomi, Giancarlo Paganin and Cinzia Talamo. 41St IAHS WORLD CONGRESS, Sustainability and Innovation for the Future 16th September 2016 Albufeira, Algarve, Portugal

[3] Badrinath, Amarnath Chegu, Yun-Tsui Chang, and Shang-Hsien Hsieh. "A review of tertiary BIM education for advanced engineering communication with visualization." Visualization in Engineering 4, no. 1 (2016): 1-17.

[4] Ayer, Steven K., J. Cribbs, J. D. Hailer, and A. D. Chasey. "Best practices and lessons learned in BIM project execution planning in construction education." In Proceedings of 9th BIM Academic Symposium and Job Task Analysis Review, Washington, DC, pp. 167-174. 2015.

[5] Badrinath, A., Chang, Y., Lin, E., Hsien, S., & Zhao, B. (2016). A preliminary study on BIM enabled design warning analysis in T3A Terminal of Chongqing Jiangbei International Airport. In Proceedings of the International Conference on Computing in Civil and Building Engineering (ICCCBE) (pp. 485-491).

[6] Yang, Tianqi, and Lihui Liao. "Research on building information model (BIM) technology." 世界建筑 5, no. 1 (2017): 1-7.

[7] G. Carbonari, S. Stravoravdis, C. Gausden, “BIM implementation for existing Industrial shades for facilities management: A framework and two case studies”, Volume: 149, 2015.

[8] Yu-Cheng Lin, Yu Chih Su, “Developing mobile and BIM based integrated visual facility maintenance management system”, Volume:2013, August 2013.

[9] N. A. H. Hadzaman, R. Tukin, A. H. Nawawi, “Industrial shade information modelling the impact of project attribute towards client demand in BIM based project”, Volume: 149, 2015.

[10] Anderson O. Akponeware, Zulfiker A. Adamu, “Clash detection or clash avoidance? an investigation into coordination problems in 3D BIM”, August 2017.

[11] S. S. Walunjkar, “Improve the productivity of Industrial shade construction project using clash detection application in BIM”, Volume: 04, March 2017.

[12] Bahriye Ilhan, Hakan Yaman, “BIM and sustainability concept in construction project: a case study”, 2016.

[13] Timothy O. Olawumi, Dani al W. M. Chan, “Beneficial factors of integrating information modelling and sustainability practises in construction project”, January 2018.

[14] Iris D. Tommelein, Sepide Gholami, “Root causes of clashes in Industrial shade information models”, 2017.

[15] Ahmed Elmaraghy, Hans Voordijk, Mohamed Marzouk, “An exploration of BIM and lean interaction optimizing demolition projects”, IGLC-26, July 2018.

[16] Olugbenga O. Akinade, Saheed O. Ajayi, Muhammad Bilal, “Designing construction waste using BIM technology: stakeholders’ expectations for industry deployment”, 2018.

[17] Tomohiro Fukuda, Kazuki Yokoi, Noboyoshi Yabuki, “An indoor thermal environment design system for renovation using augmented reality”, May 2018.

[18] Jack C. P. Cheng, Luren Y. H. Ma, “A BIM based system for demolition and renovation waste estimation and planning”, 2013.

[19] Antonio Galiano-Garrigos, Maria Dolores Andujar-Montoya, “Industrial shade information modelling in operation and maintenance at the university of Alicante”, 2018.

[20] Hossain Md Aslam, Haron Ahmad Tarmizi, “Intelligent BIM record model for effective asset management of constructed facility”, 2018