

CONSTRUCTION TECHNOLOGY AND BUILDING INFORMATION MANAGEMENT ACBA7002

TECHNICAL CASE STUDY REPORT ON BUILDING INFORMATION MANAGEMENT

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ABSTRACT

Evolving business requirements and the United Kingdom (UK) administration's 2016 "BIM deadline" have significantly pushed for improved BIM instruction in UK universities of higher education. This report describes a strategic strategy taken in the University of Wales Trinity Saint David's SA1 campus. The strategy of embedding BIM into current courses was chosen from various approaches offered by the literature. Three kinds of BIM Learning Outcomes (BIMLOs) were defined: knowledge and intellectual components, practical skills, and transferable abilities(*How universities teach BIM 2023 UK*). Case studies in the research demonstrate the multiple advantages of BIM (Building Information Modeling) and the challenges that partners in such projects may confront. The desire for the development of client owners is now seen as a critical motivator and driver for the construction sector to begin to modernise and use Building Information Modelling (BIM). Furthermore, clients may encourage innovation to reap significant benefits from BIM. Nevertheless, client anxieties and a need for a complete grasp of the advantages of BIM and the standards required to realise these advantages prevent BIM from becoming more broadly embraced across building projects. As a result, customer management must develop the necessary competencies to facilitate the Bim adoption process and realise the intended advantages of BIM(*BIM implementation process: UK ...*). As a result, this article aims to identify the essential success characteristics that help customers fulfil their duties in the BIM adoption process.

1. INTRODUCTION

Since 1944, a number of both government and business developments have appealed for substantial reforms and transformation in the UK construction sector owing to a variety of concerns, the most serious of which are inadequate productivity, waste reduction, and sustainability. The release of the UK Government Construction Strategy in May 2011 signalled the UK Government's strong dedication to driving transformation and innovation within the sector, with aspirational objectives to be met by 2025, including a 33% reduction in initial and maintenance cost, a 50% reduction in time from conception to completion, a 50% decrease in carbon emissions, and a 50% increase in exports. Building Information Modelling is part of this commitment (BIM) (*BIM implementation process: UK ...*).

In recent decades, the UK Government has made a big push to compel the use of comprehend BIM for its nationally acquired sustainable construction assets beginning April 4th, 2016. The goal of legislating BIM is to enhance the industry's overall effectiveness by bringing a significant shift in not only the project execution process (i.e. Capital Expenditure, CAPEX) but also throughout the whole asset lifespan. The procedure of digitisation project documentation, from the inception to the operating phase of the constructed asset, necessitates a cultural shift (*BIM implementation process: UK ...*). Additionally, such a shift is only possible by implementing innovative company operations supported by a new set of competencies and capabilities.

In particular, BIM may be used to improve the effectiveness of the built asset lifespan, create a safer and more efficient environment for its inhabitants, and make its proprietors more economically competent throughout their existence. As a result, BIM is gradually being ingrained in the practices of major industry participants, including consultants, contractors, suppliers, and client organisations (*BIM implementation process: UK ...*). Nevertheless, the extent to which BIM can be appropriately adopted to optimise its advantages heavily depends on the organisation's maturity in applying and managing the adoption. Although a few companies in the supply chain may have employed BIM to boost efficiency and cooperation, its advantages will be limited once clients provide a clear mandate. Recent polls show that clients may play an important role in expediting the process of innovation and driving the sector to accept change. Furthermore, research indicates that customers may promote innovation to gain critical advantages from implementing BIM, such as time and cost savings, improved facilities management, and information management.

Client and construction stakeholders' growing acceptance of Building Information Modelling Technology (BIM-t) demonstrates a substantial development from the previous way of development, building, and management of construction works to the present trend of BIM-t use. BIM-t usually provides specialists with reliable building data and up-to-date project information at all times. This improves the building project's efficiency, constructability, ease of material scheduling, and conformance to the planned 3D virtual design. The information obtained to model the building demands enough attention and precision to modify it. As a result, BIM-t can simplify the development of building projects (*Critical Review of the*

impacts of successful BIM..). All through the lifespan of a building project, BIM-t increases cooperation among built environment experts. When BIM-t is appropriately applied, it improves communication and technology solutions due to the systematic method involved. To successfully use BIM-based solutions, construction companies require proper communication.

Furthermore, to properly use BIM-t, all project staff must collaborate from the beginning of the task. As a result, cooperation among contractors is based on ideals such as accurate decision-making, confidence, practical cooperation, appropriate transparency, uniform reward, accessible information dissemination, risk-taking, usage of BIM-based technologies, and complementary documents. Adopting BIM and regulatory authorities shapes BIM's strategy, technology, and process aspects in foreign nations. The responsibilities of such bodies have been evaluated and categorised for six countries, notably: Denmark, Finland, Hong Kong, Norway, Singapore, and the United States, and academic institutions must work together with the ambitions of such bodies. In the United Kingdom (UK), for example, the BIM Task Group is a primary interest group composed of government, business, and academia specialists. The BIM Work Group (2014a) has admitted that BIM is "such a broad open issue with perceptions changing across the supply network that we might have spent a year simply attempting to define BIM". This shows that attempting to find a uniform strategy for teaching BIM, even within the same nation, may need to be more practical; hence, mutual interest would be necessary to accept diverse viewpoints or perceptions of BIM (*Critical Review of the impacts of successful BIM..*). The BIM Task Group also suggests that digital toolsets (e.g., authoring and collaborative software) are required to deploy BIM in the UK.

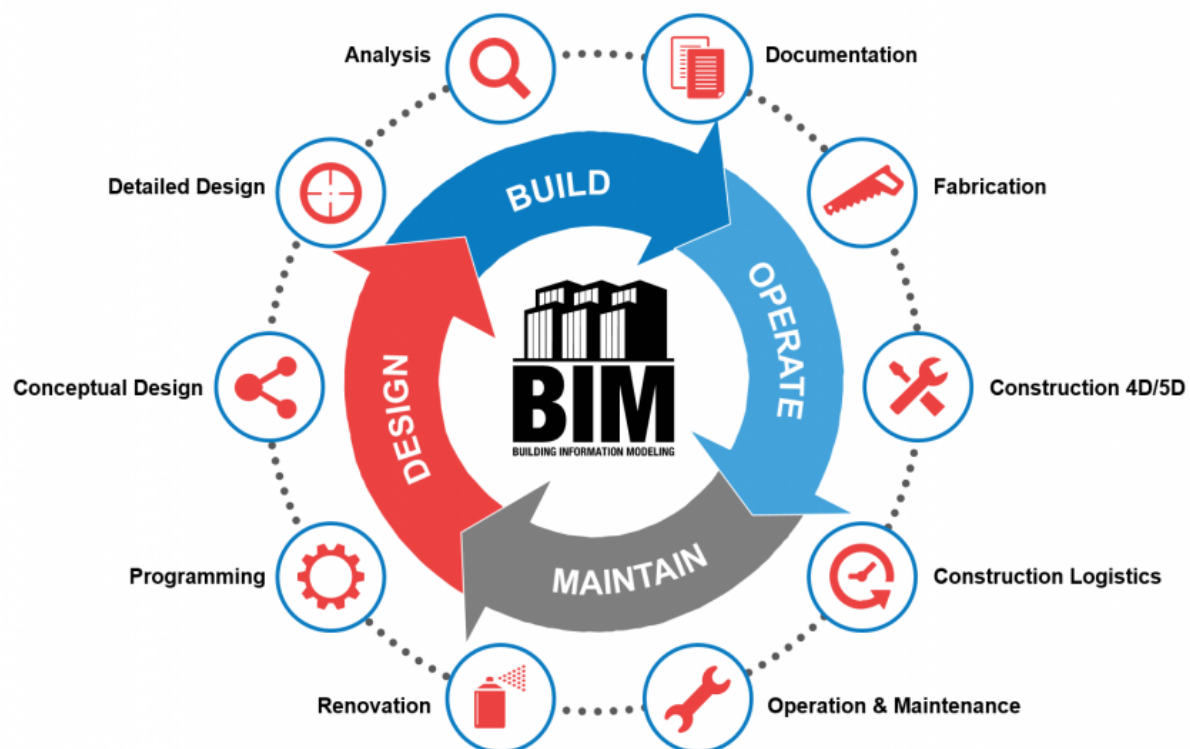


FIGURE 1: BUILDING INFORMATION MODELLING (BIM) (Maimann, 2018)

1.1 BIM IMPORTANCE

The design phase is most closely related to BIM. Construction managers (CM) rarely engage in model writing, but they are critical in ensuring that the essential aspects required to produce a quality outcome are present and proper. Further than the design stage, construction managers must grasp the procedures and tools utilised throughout one project's lifespan. The asset must be managed from creation to operation and decommissioning. To reap the most benefits from BIM data, construction managers must comprehend, analyse, share, and authenticate it. They must better introduce additional building practices, planning, pricing, reliability, collaboration, production, succession, and facilities management, to mention a few. The construction manager must explore new tools, procedures, and skill sets to take on this enlarged responsibility(Ciob home page | ciob).

1.2 BIM PROCESS

The information Delivery Cycle establishes a logical structure for generating relevant information at various phases of the building's existence. The choice to build, extend, destroy, or renovate will be made in response to an acknowledged need. This results in a customer brief and the client clearly stating their information needs to the supplier chain. The customer is responsible for providing various information needs connected to an asset's delivery or operational phase. This information may differ based on what is essential to the client. These specifications should be presented so they may be included in project-related appointments or instructions and communicated to designers, engineers, contractors, and suppliers (Ciob home page | ciob).



FIGURE 2: BIM PROCESS WORKFLOW (BIM-based process workflow 2022)

1.3 BIM EXECUTION PLAN (BEP)

When integrating BIM into a project, the development team should plan how BIM will be implemented as soon as feasible. A BEP consists of four steps:

- Recognise high-value BIM applications within the project planning, design, construction, and operating stages.
- Create process maps to design the BIM execution process.
- Describe the BIM outputs as information exchanges.
- Create the framework to enable execution, such as agreements, communication protocols, technologies, and quality assurance.

The purpose of designing this organised approach is to encourage project team planning and direct communication throughout the early stages of a project. The team in charge of the planning process should comprise representatives from all groups with a stake in the project. Because there is no ideal technique for implementing BIM on every project, each team must successfully build a customised execution plan by knowing the project goals, project characteristics, and team members' skills (*Ciob home page | ciob*).

The BIM Execution Plan (BEP) describes how a collaborative BIM-supported project will work out information modelling parts. The purpose of creating a BEP is to encourage project team strategy and direct contact throughout the early stages of a project. Because there is no one ideal technique for implementing BIM on every project, a bespoke execution plan is established for each project, stressing the project goals, project features, and team members' competencies (*Ciob home page | ciob*).

1.4 BIM MATURITY LEVELS

BIM maturity levels define the complexity of a BIM project. They are helpful because they outline whatever the supply chain is required to produce while also allowing the client to comprehend what the supply chain is delivering clearly.

- **LEVEL 0 - PRE BIM** - This phase is the beginning point, the situation before BIM deployment, and it denotes no cooperation among project team members and is classified as unmanaged CAD. Usually, 2D documentation is utilised to provide information(*Ciob home page | ciob*). Though 3D representations are possible, 2D is the foundation for all papers. Numbers, cost estimates, and requirements are typically separate from the graphical model or documentation. There is no digital partnership at this time. Paper drawings, computerised prints, or a combination of the two are produced.
- **LEVEL 1 - OBJECT BASED MODELLING** - Models are created using object-based 3D parametric software. Users create models at all stages of a building, and the model serves as the foundation for 2D documentation and 3D visualisation. Minor process modifications and contractual relationships distinguish stage 0 from stage 1(*Ciob home page | ciob*). In stage 1, a combination of 3D CAD for idea

development and 2D CAD for documentation and product information. Electronic data sharing occurs from a single data environment, which the contractor frequently handles. Collaboration between disciplines does not take place.

- **LEVEL 2 - COLLABORATIVE BIM** - Several disciplines actively interact via a model-based collaboration process. Collaboration is frequently accomplished through the use of a cloud-based application. Contractual changes are required, and models can be connected to various analytical tools. Models are used to evaluate processes(*Ciob home page | ciob*).
- **LEVEL 3 - INTEGRATED BIM** - Significant modifications to contractual connections, risk distribution models, and procedural processes are required. A shared multidisciplinary approach is required to offer project stakeholders two-way access, which will eventually lead to Integrated Project Delivery (IPD) Level 3's particular elements and characteristics have yet to be established, although they are expected to be centred on open standards and will necessitate new legal frameworks(*Ciob home page | ciob*).

2. BIM FUNDAMENTALS

2.1 BIM DIMENSIONS

Dimensions are frequently used in BIM models. Information in a typical project is represented through 2D graphics and text. The geometry of the 2D graphics is specified using lines and curves, leaving the receiver to determine what is lacking. Additionally, the information concerning what is being depicted is frequently given in requirements in another document without connection to the drawing(*Ciob home page | ciob*). It is up to coworkers to understand where to alter amounts, text, lines, and curves as changes take place. There is a rising tendency in contemporary BIM literature to refer to specific purpose models based on the five essential applications of BIM: model-based coordination, model-based scheduling, model-based estimating, model-based facilities management, and model-based analysis.

- **3D** - A 3D BIM model comprises 3D items that constitute the information model. In virtual worlds, these items depict the building or its areas. These 3D objects have information such as length, breadth, and height. Other details, such as materials and finish, can be entered. The primary advantages of a 3D digital model are increased coordination, visualisation, and basic information collection(*Ciob home page | ciob*).
- **4D** - A 4D model may be utilised throughout the project. It may be used to address construction demand during the conceptual design phase. It may be used during the construction stage to confirm finished job prices, display work to proprietors, offer health and safety instructions and explain contractor outstanding invoices to the

proprietor for the final project. Once a 4D timetable is created, it is simple to manage and change.

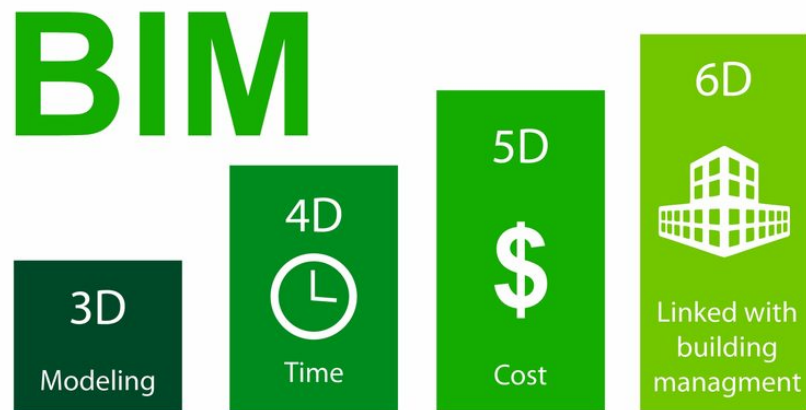


FIGURE 3: BIM DIMENSIONS (BIM 4d,5d,6d)

- **5D** - The 4D model is supplemented with cost analysis in 5D modelling, also known as design estimation. A model-based timetable, also known as a 4D schedule, is linked to cost information, allowing the proprietor to know precisely how much the contractor should bill at any given moment. The process has been modified in recent years, with 5D estimations performed in the manner of a take-off, with the model used to identify quantities of components and correlate prices with those items for predicting objectives(*Ciob home page | ciob*).
- **6D** - The sixth dimension is Facilities Management, which focuses on using model information to lower owners' costs across the facility's life cycle or structure. Asset Information Models are another name for 6D BIM models (AIM).

3. BIM IMPLEMENTATION

3.1 FIELD CAPTURING

A 3D model of current circumstances for a location, services on site, or a specific region or space inside a facility is created. Based on the goal and what is most valuable for the project, the model might be created using modelling software, laser scanning, or other surveying approaches. Laser scanning generates an exact 3D point cloud, which may be connected to the BIM model and utilised to model the space or evaluate existing systems. With the aid of specialist plugins, authoring software is quickly advancing nowadays, making it feasible to nearly immediately model from the point cloud(*Ciob home page | ciob*).

On the peninsular location at the end of Kings Road in Swansea, there will be an academic building and library called SA1 Swansea Waterfront. The construction is a component of the university's larger estates reconfiguration. It will help the institution achieve its goal of

motivating people and producing thoughtful graduates and professionals who can have a positive impact on society in the next decades(*UWTSD sa1, cewales.org.uk*). In order to scan the complete building UWTSD SA1 campus, following requirements are used:

3D laser scanning, point cloud manipulation software, BIM-compatible modelling software, and traditional surveying tools.

3.2 SOFTWARE USED - REVIZTO

Revizto unifies BIM intelligence and makes it immediately accessible and actionable for the entire project team. With Revizto's advanced Issue Tracker predefined workflows project team members can identify and manage model-based issues in the 3D space and 2D sheets, including addressing clash groups. Revizto provides unified access to a project's data both for 2D and 3D workflows, so anyone can use it depending on project requirements(Revizto, 2022). An integrated approach for clash detection, categorization, and problem monitoring from an unified framework is what is referred to as the new "Revizto+" with automatic clash detection." From an unified platform, several participants may perform conflict detection at once, with the findings being precisely filtered for key parties. Five distinct collisions may be found using the platform: hard, clearance, clearance with separate both horizontal and vertical offsets, tolerance, and acceptance with distinct horizontal and vertical offsets. Findings may be filtered, and detecting results can be aggregated for additional refinement(AEC Magazine, 2022).

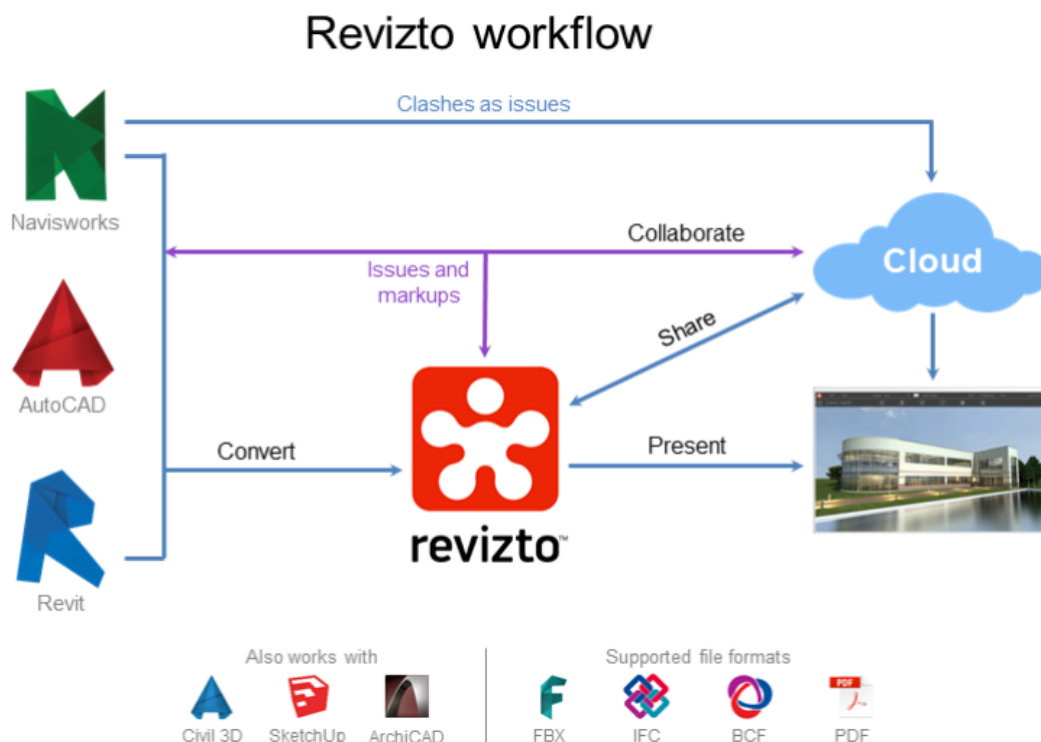


FIGURE 4: REVIZTO WORKFLOW (blog, 2017)



FIGURE 4: CAMPUS BUILDING

3.3 3D LASER SCANNING

Through quick, user-friendly, precise, and portable hardware and software, the Leica RTC360 3D reality capture system increases efficiency and productivity in the field and in the office by enabling users to record and capture their surroundings in 3D. Professionals may manage project complexity with precise and trustworthy 3D depictions and learn about the potential of every site with the RTC360 3D laser scanner. The RTC360 solution effectively combines the RTC360, an elevated 3D laser scanner, Leica Cyclone FIELD 360 smartphone app for edge calculating for instantly having to register scan results in real-time, and Leica Cyclone REGISTER 360 office software to incorporate your 3D model into your workflow. This system is incredibly portable, heavily automated, intuitive, and intended for high effectiveness. In less than two minutes, capture scans with enriched High-Dynamic Range (HDR) images. Pre-register your scans in the field automatically by recording your movements from station to station. Add information tags to your data collection to better represent site reality, show planning possibilities, and raise situational awareness among your employees(*Leica RTC360 3D Laser Scanner*).

3D reality capture is now faster than ever thanks to the new Leica RTC360 laser scanner. The production of coloured 3D point clouds may be finished in under two minutes using a sophisticated HDR photography system and a measurement rate of up to 2 million points per second. Additionally, targetless field registration that is automated (based on VIS technology) and the automatic, smooth transmission of data from the site to the office save time spent in the field and increase productivity(*Leica RTC360 3D Laser Scanner*).

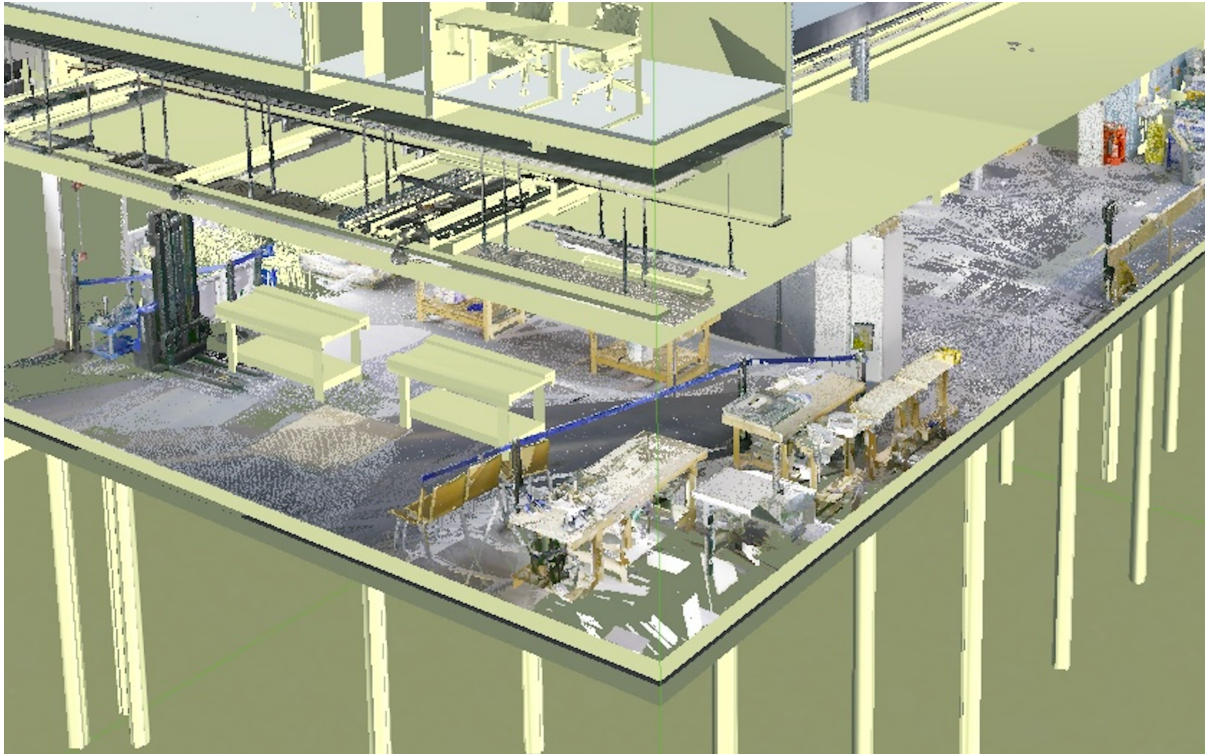


FIGURE 4: 3D LASER SCANNING OF GROUND FLOOR

3.4 3D COORDINATION AND CLASH DETECTION

By analysing 3D models of the construction system, clash detection software is utilised to coordinate field disputes. Major structural conflicts are to be removed before installation. Colour coding is used to make each component and subsystem easier to grasp visually. Geometry or rulesets are used to identify collisions. Geometry-based clash detection may identify conflicts between two or more items. When a column is positioned on a slab without a foundation, for instance, or if a space is large, adequate as it ought to be, according to construction laws or space needs from the proprietor, rule-based conflict detection identifies these instances. The integrity of the design is examined using rule-based collision detection(Ciob home page | ciob).

Process of Clash Detection

In a Level 2 BIM process, a number of federated models are produced, and synchronised data are utilised to produce the master model. When models are worked on using BIM integration tools and software, BIM modellers look for inconsistencies in their models. The ability to check for conflicts within certain subsets, such as those between architectural features and structural beams, columns, ducts, and plumbing parts, is becoming possible thanks to more sophisticated collision detection software. Vibrant colours are used to indicate conflicts between two separate elements(Multani, 2022).

Process of Clash Resolution

A clash report is produced when a conflict detection method is done, and this report typically comprises several instances of the same issue. Even though there is only one problem (the

positioning of the pipes) that has to be fixed to stop all conflicts, when a given length of piping intersects with five beams, it seems as though there are five collisions. A key step in the BIM process is evaluating and settling design disagreements. These automated processes are a component of a bigger design coordination process that creates a BIM model that is well-organised and free of clashes (Multani, 2022). Geometrical phenomena like pipes running through walls are examples of clashes. When numerous sequential tasks are planned to be completed at once or in opposite order, or when updates and adjustments to the designs are not done. The use of BIM collision detection in an AEC project has a number of benefits.

Automated Process of Clash Detection and Resolution: With the state-of-the-art BIM toolset, multi-element multi-trade clash detection is automated. Engineers and architects can model anything in advance thanks to BIM. Due to the fact that all of the components were made off-site, there are therefore less disputes on the construction site.

3.5 BIM IN FACILITIES MANAGEMENT APPLICATIONS

Building information modelling (BIM) for use in Facilities Management (FM) applications is a developing field of study that is founded on the idea that BIM data created and stored throughout the lifespan of a facility may enhance building performance. This study intends to examine the benefits of BIM and the obstacles preventing its implementation in FM applications using this claim as a starting point (*BIM in FM applications*).

The cost of a building's lifetime is mostly driven by its operating phase. Governments from all over the globe are aware of the inefficiencies impacting the construction sector as a whole and have either encouraged or required the adoption of Building Information Modeling (BIM) as a tactic to combat diminishing productivity. For instance, starting in 2016, all federally purchased projects must use BIM level 2 federated models stored in distinct discipline "BIM" tools with connected data, including the transfer of digital data necessary for the operational stage. Although this requirement specifies an operational handover definition, there hasn't been much study on BIM in the FM business (*BIM in FM applications*).

Challenges of BIM in FM applications

In the FM sector, the cultural approach to implementing new procedures and technology is regarded as a major obstacle. The FM sector is generally conservative when it comes to adopting new technology, hence adoption of BIM for FM will remain low until its advantages are amply shown. The lack of customer demand for BIMs for FM is real, and it is made worse by a general lack of cooperation among project stakeholders on modelling and model utilisation. The lack of client awareness is made worse by the lack of BIM knowledge and expertise among FM experts, and these two reasons together are preventing BIM adoption in FM applications (*BIM in FM applications*).

A key area of problems is the absence of a statutory and contractual structure for the deployment of BIM in general and BIM for FM in particular. For the coming years, textual and two-dimensional visual agreements between the parties will be the only acceptable method of

communication in the building business due to legal and liability constraints. The provenance of the BIM data and the way to preserve it all through copyright as well as other regulations should be determined as the first legal risk. In BIM policy, distribution deals are developing as a workable choice that permits restricted usage to a third party while preserving copyright and absolute control. However, the problems with integrated data and system validation provide a hurdle to this strategy(*BIM in FM applications*).

3.6 ROLE OF BIM IN SUSTAINABLE CONSTRUCTION

The estimated 37% worldwide energy and process-related CO₂ emissions that are attributed to buildings during their entire lifespan demonstrate the significance of the built environment in combating climate change. Considering that many countries, sectors, and organisations have established their own net zero emissions objectives, this article looks at how BIM is promoting more environmentally friendly building practices. According to the UK government's National Infrastructure Survey, "strong, revolutionary action" is required to meet the country's carbon emission reduction objectives of 68% and 78%, compared to 1990 levels, by 2030 and 2035, respectively. Significantly, the Survey asserts that the embodied carbon in constructed facilities should also be included in these proposed percentage decreases(Fazzan, 2022).

Reduced environmental effect is, of course, a key objective of sustainable building. This is accomplished by taking a variety of steps, including employing recyclable and renewable materials when constructing new buildings, consuming less energy, and producing the least amount of trash feasible during the whole building lifespan. BIM can significantly bring value in this final area—reducing waste. BIM is a method for designing and comprehending a structure in a virtual setting. In order to deliver projects more successfully, it makes advantage of collaborative working procedures and information-rich 3D models. Despite being primarily linked with the planning and construction stage, BIM is advantageous across the whole project lifetime. In reality, using BIM minimises a building's whole lifespan environmental footprint since BIM procedures result in so many efficiencies(Fazzan, 2022). Four prime examples are given below:

- **Increasing transparency to cut down on waste**

By applying cutting-edge analysis to foretell a building's operating efficiency long before it is completed, BIM promotes a more accessible design process. By implementing energy-saving measures at every step of the building's lifetime, designers may utilise this knowledge to improve the effectiveness of the structure from the beginning.

- **Early detection of any mistakes or dangers**

Clash tests, which assess if any two construction components—for instance, plumbing and walls—are clashing with one another are a common practice. If incompatibilities are discovered during modelling, it is simple to understand how this might result in material savings as well as safer working conditions for construction personnel.

- **Enhanced precision**

Additionally, manufacturers may use BIM to produce more precise components away from the project site, fostering a "right first time" attitude. By doing this, it is made sure that waste and material consumption are kept to a minimum, overordering is prevented, and the energy resources that would normally be utilised for redundant processes are conserved.

- **More building control when in operation**

For a building to be run at its highest level of energy efficiency once a project is finished, 3D models may be easily shared. Key operational processes can have major repairs and replacements planned and coordinated to minimise both the interruption and environmental effect. A digital twin, a 3D model intended to properly represent the actual project, is likewise made possible by BIM.

4. CONCLUSION

Although the advantages of BIM have been proved, there are still expenses associated with adoption. Short-term thinking is a concern in construction projects since the project owner may not be able to benefit from their expenditures in a specific project. More case studies are needed to demonstrate the profitability of BIM while also exposing how process difficulties were handled in these projects. At the same time, performers face competitive threats if they share their findings with the whole business(*Revizto*). The engineering design field has been totally changed by BIM Clash Detection. By allowing everyone to view, assess, and avoid disagreements in advance, the technology is delivering a much-needed lifeline to an industry racked by thousands of issues. Concurrently, BIM and clash detection have simplified the lives of architects and engineers by allowing them to manage and monitor diverse components without sacrificing uniqueness at the last minute in order to complete a project(Multani, 2022).

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APPENDIX

- Images from Revizto Software

