

University of Wales

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MSc in Sustainable construction



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**Written Assignment for Module: Construction Technology And
Building Information Management (ACBA7002)**

**Assignment Title: BIM as a whole life process and a Building
Management Tool. Technical case study**

Student ID Number: 2209422

Word count:4805

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1.1 Introduction

Building Information Management (BIM) is used to design 3d prototype of a building using a computer aided drawing tools such as Revit 5. BIM acts as a center database to the stakeholders to manage various tasks such as maintenance for the build structures [1].

The University of Wales Trinity St David (UWTSD) is located in various locations in Swansea city as well as towns such as Lampeter and Carmarthen in Southwest Wales. The analysis in the report is focused on SA1 campus IQ building, Fforwm and CWIC building. These buildings are designed to provide facilities such as (1) teaching rooms with integrated audio, visual and ICT equipment; 2) Cafes with integrated kitchen equipment; 3) High Tech IT spaces 4) Library and Social Spaces. Most spaces are equipped with Heating, ventilation, and air conditioning (HVAC) systems, electrical and internal water piping. Apart from these SA1 buildings are designed for state-of-the-art high computational systems [2].

Analysis of the “as built” and “as designed” are compared. In the due process, issues with software model and original model are stated.

2.1 Analysis of “As built” vs “As Designed” of structures.

This section examines the utilisation of Building Information Modelling (BIM) methodologies and digital technologies for the purpose of obtaining 'As Designed' and 'As Built' information. The study critically evaluates the data comparison between them. Comprehensive data would be necessary and stored in the Project Information Model (PIM), which is created and maintained collectively within the Common Data Environment (CDE) [3].

The project's Building Information Modelling (BIM) scope would entail a collection of deliverables categorised as either 'Planned (P)', 'Required (R)', or 'Not Required (N)'. These deliverables would be established at different stages, namely 'Pre-Contract', 'Construction', and 'Handover', as stipulated in the BEP(see appendix). After uploading files into revit software major issues are noticed.

Issue 1: Improper geometry of built structure

3D model of Fforwm building is shown in figure 1 and built structure in figure 2. It is clearly noticed that roof of the 3d model is flat, whereas built structure is triangular dual pitched roof. This error affects in the room dimensions such as volume, area and coordinated locations. This issue can further affect in maintenance of HVAC systems, lighting and electrical systems. Each time updating the maintenance systems worsen the problem. This issue can be solved by rebuilding the top roof structure in the software.



Figure 1: Left; 3d design of Frown building. Right, Yforwm screenshot.

Issue 2: Missing exterior lighting on IFC building.

Missing exterior lighting on IFC building ,One of the major issues noticed is that M&E systems are not in the sync with the structure, so entire system is lifted by approximately by seven meters to match with the “built” structure. Screenshot of the IFC building section is shown in figure [2].

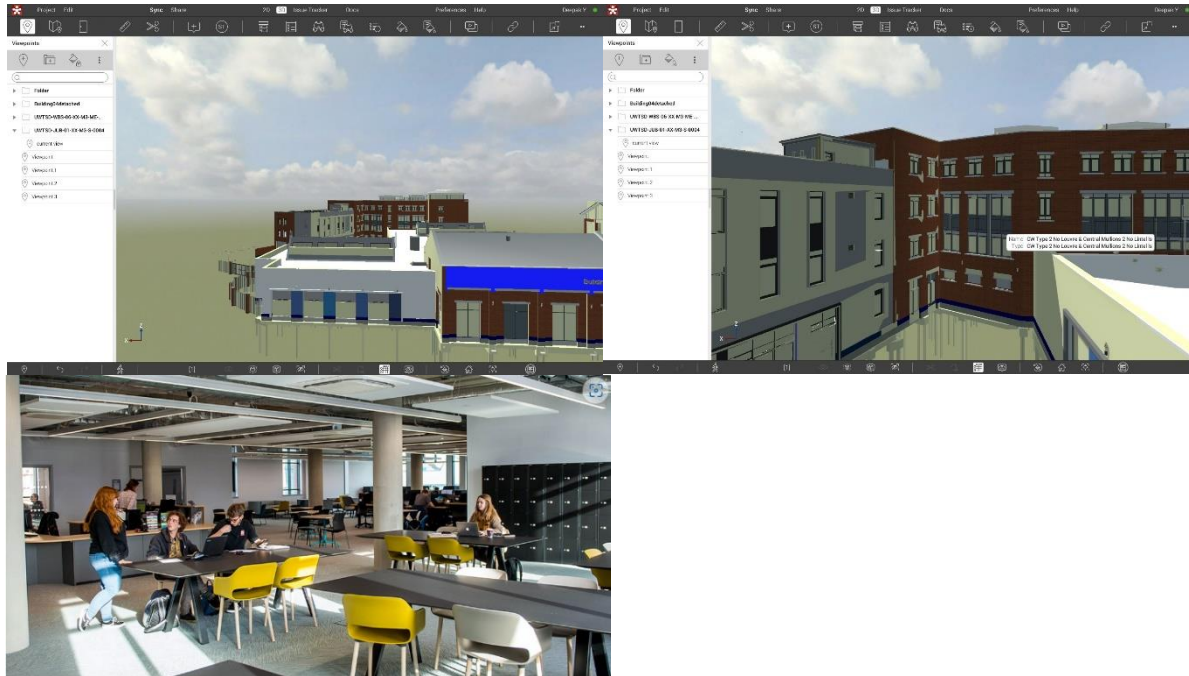


Figure 2: 3d screenshots of Exterior of buildings.

Issue 3: Clash automation compatibility

The feature of clash detection in Revit enables users to detect and address conflicts or clashes that may arise between various elements within a building model. The mechanism operates through the examination of the spatial interconnections among the constituents within the framework, detecting scenarios where multiple constituents coexist within a shared physical domain or where there is a disruption in their interaction. Clash detection is a technique that can be employed to detect discrepancies between mechanical, electrical, and plumbing systems, such as ductwork, pipes, and electrical conduits, and architectural elements such as walls, ceilings, or other features. Revit offers various tools to address clashes, including modifying the placement or dimensions of elements and altering the routing of piping or ductwork, once they have been detected. The process of detecting clashes holds significant value in the design and construction domain, as it aids in reducing inaccuracies and verifying the coherence of all constituents within the building model. Although it is very important MacBook is not compatible for clash automation as shown in figure 3.



Figure 3: 3d screenshots of Exterior of IFC CWIC building.

Issue 4: undetected sanitary objects.

After drill down from the object tree, Revit software enables to see the properties and isolate of the individual items from the entire structure as shown in the figure. Ton of information can be used such as fabrication of software, authorizing of software, constrains, geometry and many more these information's can be used in mixed environments. Detected items is highlighted in blue color and isolated objects in transparent. Revit is unable to detect all the objects under the sanitary section as shown in the figure 4. Few sanitary toilets are disabled, which make it difficult for the maintenance team to upgrade or sanitize equipment of the toilets. While trying out different options under property conditions.

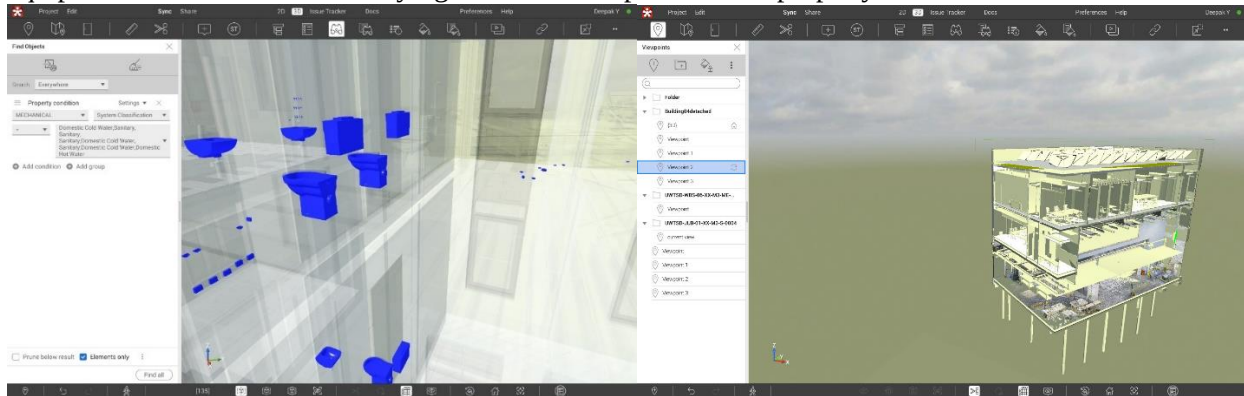


Figure 4: sanitary items in buildings and created in classroom practices.

Issue 5: Non-Sync elements

Large number of elements are not synced in CWIC workshop room as shown in the figure. The clear pixel breaking is visible in figure 5. This may be due to improper scanning, which makes tough job for the property manager. Further selecting the lights and electricals tend to select whole room which Revit is unable to distinguish the objects in the workshop room. Due to this, coefficient of utilization calculations of the electrical systems would have gone wrong.

3.1 Facilities Management

Facilities management maintains the built structures, FM team layout day to day operations and strategic operations of the building to improve the overall health of the building [4] . While the need for facility managers has always been there the field has only recently developed into a full-fledged profession due to factors such as the rise of outsourcing and the introduction of procurement methods that incorporate operation and maintenance into single supply contracts.

With the recent rise of building information management (BIM), FM needs to be involved from the beginning to make sure that the information created during the design and construction phases is useful for operational needs and asset management. This is done by turning the project information model into an asset information model that FM can use [5]. CAFM software can be used to help handle property companies and make sure they are running at their best. Responsibility matrix during the planning phase of the project is shown in figure 7. Facilities management teams can evaluate BIM to set up maintenance regimes by following these steps:

Project Information Manager	Project Delivery Manager	Lead Designer	Task Team Manager	Task Information Manager	Interface Manager	Information Author
Activities						
Enable reliable information exchange through a Common Data Environment	Assure delivery of information exchanges	Co-ordinated delivery of all design information	Production of design outputs related to a discipline specific, package based or time based task	Direct the production of task information in compliance with the standards, methods and procedures	Manage spatial coordination on behalf of a task team	Develop constituent parts of the information model in connection with specific tasks
Maintain and receive information into the information model	Confirm suppliers ability to deliver information requirements	Manage information development and information approvals		Direct the production of task information using agreed systems	Propose resolutions to coordination clashes	Production of project outputs
Enable integration and coordination of information within the information model		Confirm design deliverables				
Configure information for project outputs		Overall lead for configuration management				
Populate the information exchange format for the information model						
Authorities						
Accept / reject information exchanges within the Common Data Environment	Accept / reject information exchanges within the Common Data Environment	Confirm status and approve information for issue within the Common Data Environment	Issue approved information within the Common Data Environment	Confirm that information is suitable for issue within the Common Data Environment	Propose resolutions to clashes	Ownership of model information
No design responsibility or right to issue instructions		Approve design changes proposed to resolve clashes				

Figure 7: Responsibility Matrix

Develop a BIM model: A Building Information Management (BIM) digital model is a virtual depiction of a structure's design and construction data. The document provides an in-depth analysis of the building's components, systems, and equipment, including their properties, relationships, and interdependencies [6]. The process of creating a BIM model for a building usually involves gathering every necessary

information regarding its design and construction, which is typically done by the facilities team and contractor. The data comprises of architectural sketches, engineering blueprints, mechanical and electrical schematics, and equipment and material specifications. For instance, light fixture is shown in figure 8 which is used by maintenance team to check its condition. Subsequently, the team responsible for facilities and the contractor will utilize specialized BIM (REVITZO 5) software to generate a three-dimensional digital representation of the SA1 campus. The model shall comprise comprehensive details regarding every component, system, and equipment, encompassing dimensions, materials, and specifications. The implementation of the BIM model enables the facilities team and contractor to efficiently identify potential maintenance issues and develop maintenance plans by visualizing the building in 3D. For Common Data Environment (CDE) BIMXTRA is used in the project to achieve Level 2 BIM. As shown in graphical image 8.

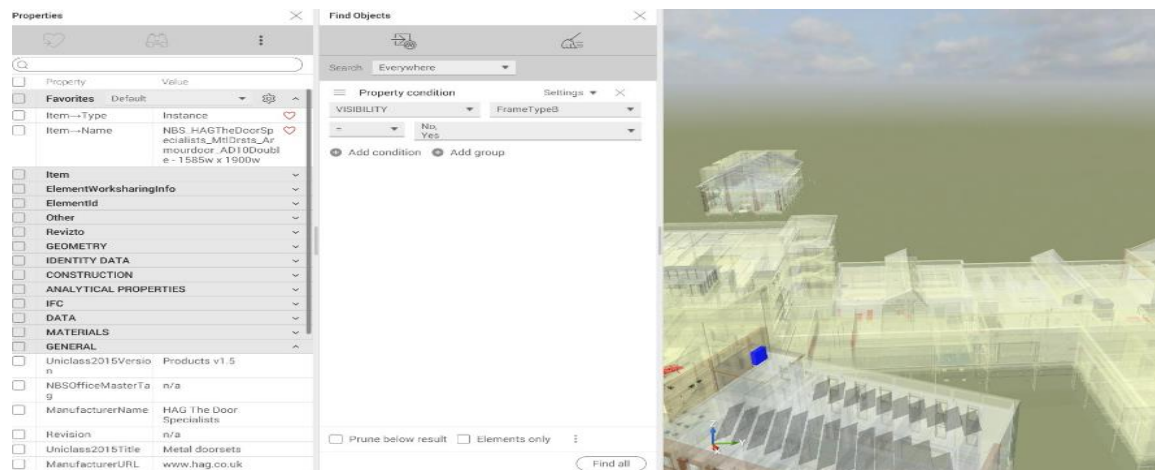


Figure 8: Light fixture.

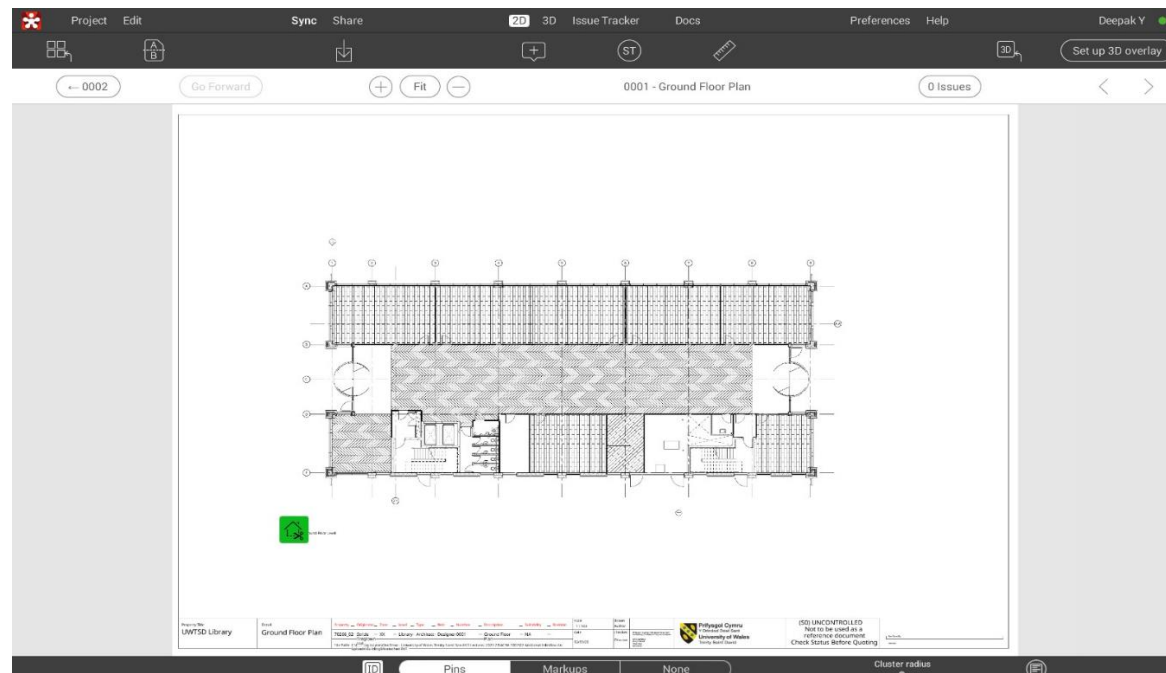


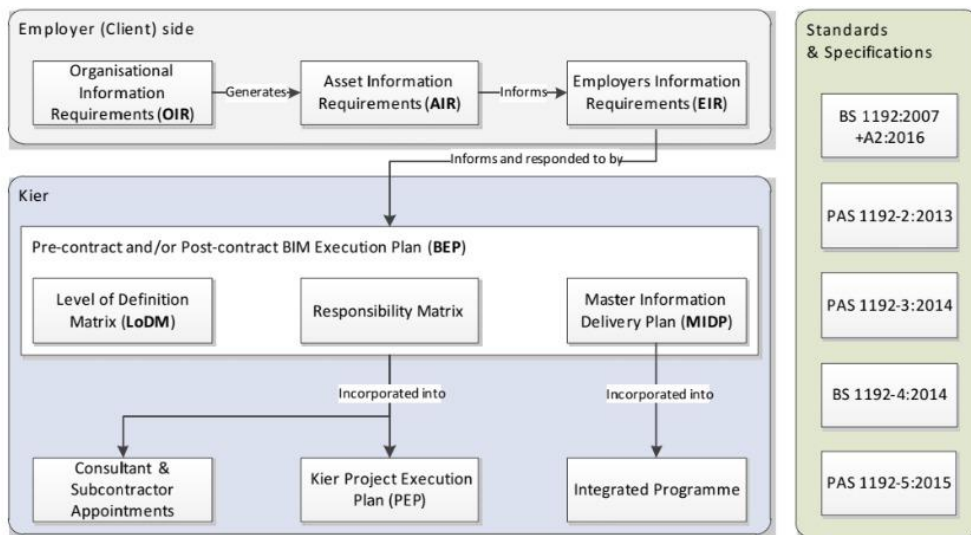
Figure 9: second floor 2d plan



Figure 10: Second floor 3d plan.

AGREED BY		
Company	Individual	Date
Kier Construction Western	Andrew Gardner	
Stride Treglown	Gareth Brown	
Jubb Consultants	Tom Marsh	
Troup Bywaters + Anders	Geraint Hampton	
Whitehead Buildings Services	Duncan Reid	
Kier Facilities management	Kaylie Boyce	
University of Wales – Trinity St David		

Figure 11: stake holders involved.



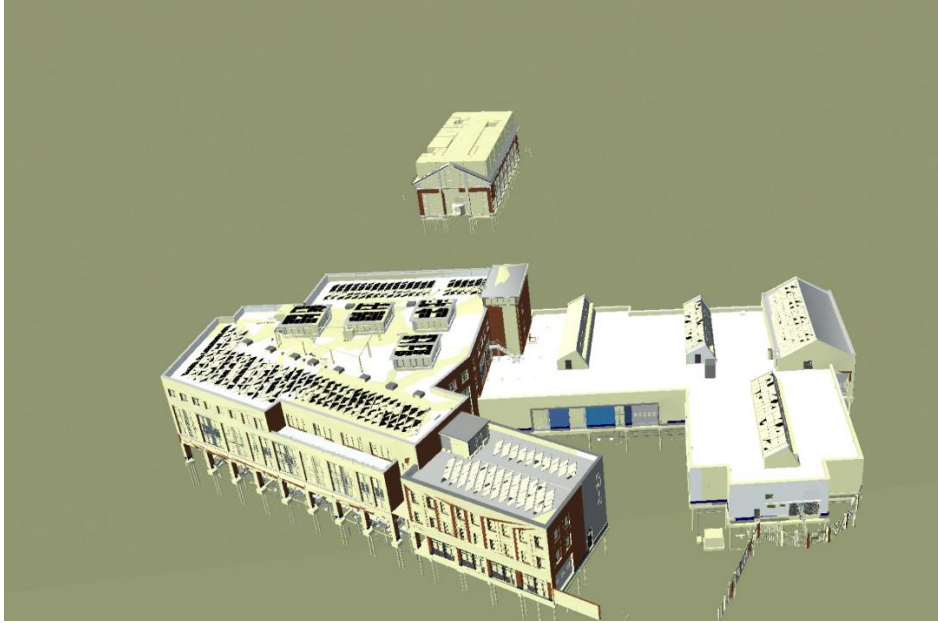


Figure 12: 3d model of SA1 campus

Contractor has accepted to produce many activities such as common data environment (CDE) established and maintained, data security requirements, sub-contractor models and many more. Mainly categorized into SETUP, CONTENT, DESIGN, COMMERCIAL, PLANNING, CONSTRUCTION, HANDOVER AND FEEDBACK. According to the KIER document Facilities manager is responsible for clash avoidance/detection workshop [7].

2) By utilizing the BIM model, the facilities team and contractor can establish a maintenance schedule based on the identification of every component, system, and equipment in the building and their respective maintenance needs. This entails incorporating metadata into the BIM model that outlines the maintenance specifications for every component, including the suggested maintenance frequency, maintenance type, and anticipated lifespan of the component. The maintenance schedule ought to delineate the frequency and nature of maintenance necessary for every component. Certain components may necessitate regular cleaning or lubrication, whereas others may require more comprehensive maintenance, such as the replacement of parts or components. The maintenance schedule must take into account environmental and operational factors that could impact the maintenance needs of each component, such as temperature or humidity levels. For instance, maintenance of fire alarm scheduling is integrated into the software as shown in the figure 13 but the alarm status is out of scope of the project. After identifying the maintenance requirements of each component and establishing a maintenance schedule, the facilities team can assign maintenance tasks to staff members or subcontractors based on their skills and availability. The integration of a computerized maintenance management system (CMMS) with the BIM model allows for progress tracking and task completion according to schedule by the facilities team and contractor. Establishing a maintenance schedule based on BIM is an essential measure for utilizing BIM to establish maintenance protocols with the contractor. It guarantees that all building components are adequately maintained based on their unique needs, which helps to extend their lifespan and avoid malfunctions or breakdowns that may interrupt operations and result in expensive repairs.

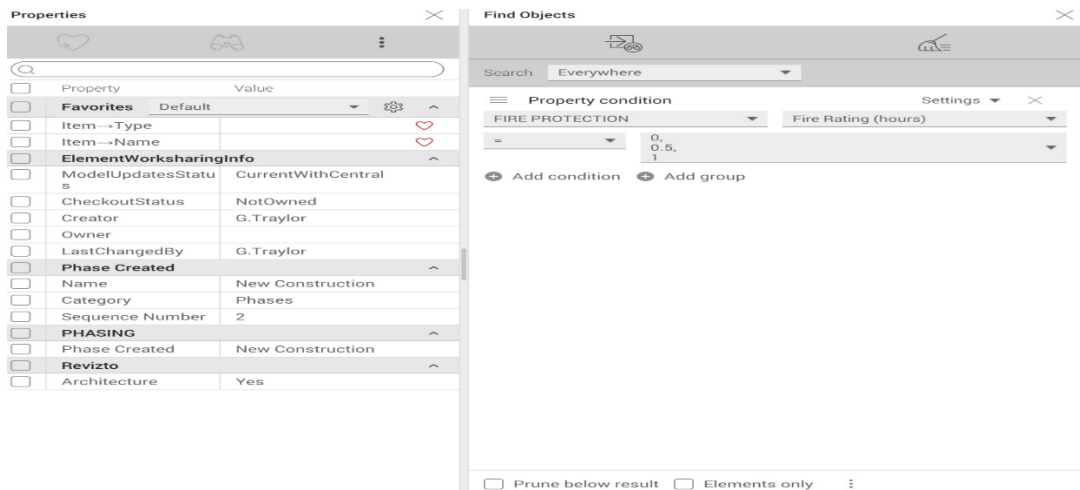


Figure 13: Fire alarm status.

Allocate maintenance tasks: After establishing a maintenance schedule based on BIM, the subsequent step is to utilise BIM to allocate maintenance tasks to staff members or subcontractors according to their availability and expertise. The integration of a computerised maintenance management system (CMMS) with the BIM model can facilitate this task. A Computerised Maintenance Management System (CMMS) is a software application that allows facility management teams to oversee and monitor maintenance operations. It enables users to schedule and delegate maintenance assignments, monitor advancement, and produce maintenance activity reports. When integrated with a Building Information Modelling (BIM) model, a Computerised Maintenance Management System (CMMS) can offer an enhanced solution for overseeing maintenance activities. By utilising the BIM model and CMMS, the facilities team and contractor are able to delegate maintenance responsibilities to staff members or subcontractors based on their availability and skillset. In case a specific component necessitates specialised knowledge for upkeep, the system can delegate the responsibility to a staff member or subcontractor who possesses the requisite skills and certifications [8]. The Computerised Maintenance Management System (CMMS) has the capability to issue alerts and notifications to prompt timely completion of maintenance tasks. This could be particularly advantageous for components that have essential maintenance requirements or are challenging to reach. Furthermore, utilising BIM for assigning maintenance tasks can enhance maintenance operations by allowing the facilities team to priorities tasks according to their significance and immediacy. In case of a critical component requiring maintenance, the system can prioritise the task over less critical ones.

It is crucial for the facilities team to oversee the progress of maintenance tasks assigned to staff members or subcontractors through the BIM model and CMMS to ensure timely completion as per the schedule. This can be accomplished by utilising the BIM model for monitoring advancement and detecting possible problems. The Building Information Management (BIM) model enables the facilities team to track maintenance progress in real-time, enabling them to monitor the status of each task and identify any potential delays or issues. In case of a prolonged maintenance task, the facilities team can analyse the reason for the delay and implement measures to resolve it before it escalates into a significant issue. Through the utilisation of the BIM model, the facilities team can oversee maintenance progress and verify that maintenance tasks are executed accurately and in accordance with the designated specifications. This is particularly crucial for components that have essential maintenance requirements or are challenging to reach. As shown in the figure 14 issues can be raised and can be notify the related department .Through proper execution of maintenance duties, the facilities team can mitigate equipment malfunctions and

reduce operational interruptions. Furthermore, the facilities team has the capability to utilise the BIM model for producing maintenance activity reports, in addition to overseeing maintenance progress [9]. This can offer significant insights into maintenance trends, such as the identification of the most frequently maintained components or the most efficient staff members or subcontractors in executing maintenance tasks.

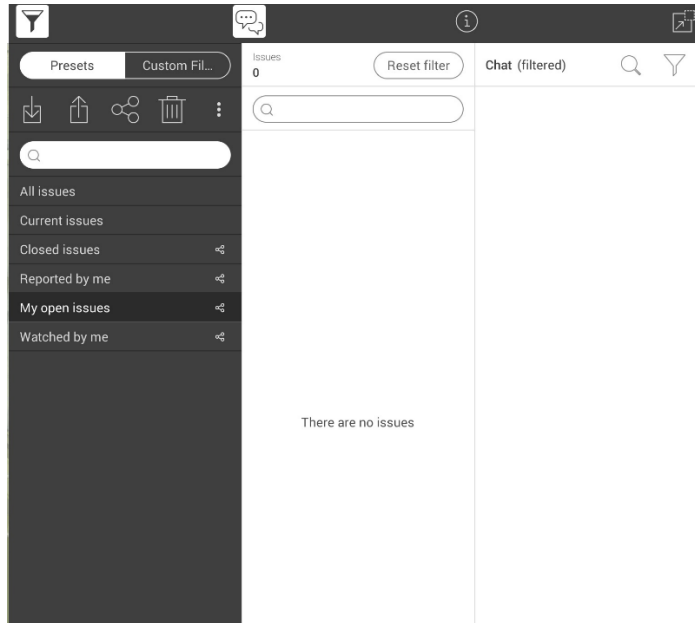


Figure 14: Issue tracker

Reporting):Utilising the BIM model for reporting holds significant importance in BIM-oriented maintenance management. Upon assigning maintenance tasks and monitoring progress through the BIM model, the facilities team can utilise the model to produce reports on maintenance activity. The reports offer significant insights into maintenance trends and performance, enabling the facilities team to gradually enhance maintenance operations. The reports can be utilised to pinpoint the components that need the most maintenance, evaluate the effectiveness of staff members or subcontractors in completing maintenance tasks, and recognise any potential issues that could impact maintenance performance. Through the analysis of the data presented in the reports, the facilities team can make necessary modifications to the maintenance schedule and enhance maintenance operations gradually (see appendix). In the event that a specific component necessitates a greater amount of maintenance than initially anticipated, the facilities team has the ability to modify the maintenance schedule to allocate additional time and resources to that component.

Utilising the BIM model for reporting can enhance communication and collaboration between the facilities team and other stakeholders, including building owners and tenants, while also streamlining maintenance operations. Through the dissemination of maintenance reports, the facilities team can exhibit the efficacy of their maintenance endeavours and offer discernment into the functioning of building components and equipment. In general, utilising the BIM model for reporting constitutes a crucial element of BIM-oriented maintenance management. Through the generation of maintenance reports and subsequent analysis of the data, the facilities team can enhance the efficiency and longevity of building components and equipment. This approach also fosters better communication and collaboration with other stakeholders [10].

However, there are also challenges that need to be addressed in order to effectively utilize BIM outputs in facilities management:

BIM is a sophisticated technology that demands specialised skills and expertise to be utilised efficiently. The lack of in-house expertise in facility management teams can pose a challenge in integrating BIM into existing processes and workflows. It may be necessary for facility management teams to invest in the recruitment and training of personnel possessing the requisite expertise to proficiently apply and utilise BIM. This could prove to be a costly and time-intensive endeavor, especially for smaller teams operating with restricted resources. Moreover, the evolution of BIM technology can pose a challenge for facility management teams to stay abreast of the latest advancements. Continual training and professional development may be necessary to ensure that employees possess the requisite expertise and understanding to utilise BIM proficiently. One of the challenges associated with expertise is the requirement for efficient communication and collaboration among diverse stakeholders. BIM necessitates contributions from various fields, such as architects, engineers, contractors, and facility managers. Efficient communication and collaboration among stakeholders are crucial for the prosperous integration and utilisation of BIM. Attaining a high level of expertise and knowledge across various disciplines can be a challenging task. As show in the figure 15 library floor plan is not designed in 2d model. It is actually an unbuilt structure.

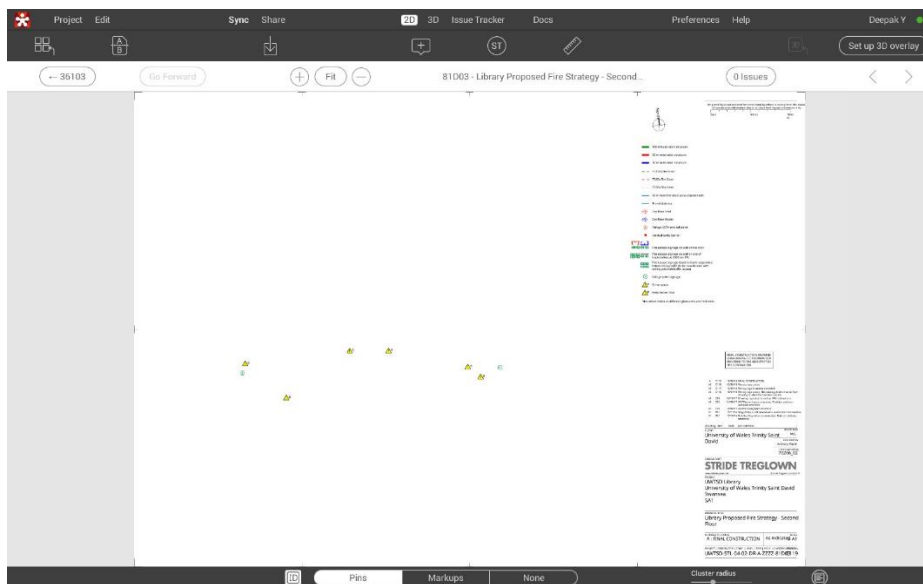


Figure 15: Unfinished floor plan.

The implementation and maintenance of BIM technology can be costly, especially for smaller facilities management teams with limited resources. The expenses associated with adopting BIM may encompass procuring hardware and software, along with the expenditure of recruiting and training personnel who possess the requisite proficiency to utilise the technology efficiently. Continuing expenses might comprise of upkeep and assistance charges, along with the expense of enhancing the technology in the long run. Facility management teams should evaluate the expenses related to adopting and upkeeping BIM. They should also assess if the advantages of utilising the technology surpass these expenses. Conducting a cost-benefit analysis and evaluating the long-term advantages of implementing BIM in facility management may be necessary. An additional obstacle concerning expenses is the requirement for efficient allocation of resources and budgeting [11]. Effective allocation of resources is crucial for facility management teams to ensure adequate funding and staff resources for the successful implementation and

maintenance of BIM. Careful planning and budgeting, along with continuous monitoring and evaluation of costs and resources, are necessary for successful implementation.

One of the challenges that facility management teams may encounter when incorporating BIM is the issue of interoperability. The complexity of BIM technology may necessitate integration with other facility management systems and software. Graduate: Facility management teams utilise various software and systems to carry out tasks like maintenance management, energy management, and asset tracking. Integration of BIM with these systems is necessary to ensure efficient data sharing and streamlined workflows. The complexity of BIM technology and the diversity of systems and software utilised in facility management can pose a challenge for achieving interoperability. To ensure effective integration of BIM with other systems and software, facility management teams may have to collaborate closely with IT professionals and software vendors. In order to tackle this challenge, it may be necessary for facility management teams to allocate resources towards providing training and assistance to personnel tasked with overseeing BIM and other software systems. As seen in section 1 many issues are identified in the software, which makes all the departments less combinable, may be necessary to establish standards and protocols for data sharing and ensure that all stakeholders involved in facility management are informed of these standards. Interoperability poses a major obstacle for facility management teams as they incorporate BIM into their processes and workflows. To tackle this challenge, it is essential to establish efficient communication, collaboration, and standardization among various systems and software utilized in facility management.

In summary, BIM outputs offer many opportunities for facilities management teams to improve their asset management processes. However, they also present challenges that need to be addressed in order to effectively utilize the data and realize the benefits of BIM.

4.1 Sustainable Measures

BIM technologies can be used to implement and improve sustainable measures in several ways, including:

Energy Analysis:

Energy analysis is a crucial aspect of utilising BIM for implementing and managing sustainability measures. BIM technology allows designers to conduct thorough energy analysis on a building's design, aiding in the identification of potential areas for energy efficiency improvements. Energy analysis is conducted by generating a digital representation of the structure and simulating its energy usage through BIM software[12]. Throughout the analysis, diverse energy-saving tactics may be examined and assessed according to the structure's efficiency. Designers may consider implementing passive solar design strategies, such as optimising the building's orientation to enhance the utilisation of natural light and heat. This could potentially decrease the building's dependence on artificial lighting and heating, leading to noteworthy energy conservation[4a]. Sy-Jye_Guo et al, conducted a study energy consumption analysis on a Civil Engineering Research Building at National Taiwan University in EQuest software [12].Energy graph is shown in fig(16)

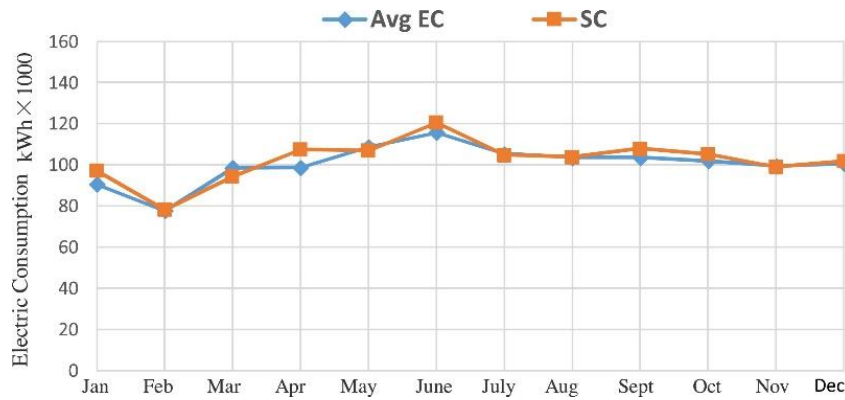


Figure 16: Energy simulation data for engineering building.

BIM is capable of facilitating the exploration of daylighting strategies that aim to optimise the utilisation of natural light and minimise the reliance on artificial lighting. Through simulating a building's energy consumption with and without daylighting strategies, designers can assess potential energy savings and determine the most efficient daylighting strategies for the building's design.

Furthermore, BIM has the capability to investigate the utilisation of high-efficiency insulation and HVAC systems. Through simulating the energy consumption of a building using various insulation and HVAC strategies, designers can evaluate potential energy savings and choose the most efficient design options [14].

Lifecycle Assessment:

similar study is conducted by Zhenmin Yuan et al conducted on BIM models on a lifecycle assessment of the green buildings, which considers the environmental impact of the building from construction to demolition. This can help facilities management teams to identify opportunities to reduce waste, minimize environmental impact, and increase the lifespan of the building. The team have developed a novel code to integrate a life cycle into BIM-VCE(BIM-Value Engineering)[13]

Material Selection:

The utilisation of BIM for executing and regulating sustainability measures involves the selection of materials. BIM integration with sustainable material and product databases can aid designers in identifying sustainable material options during the design phase. This empowers designers to make knowledgeable choices regarding the materials they select, taking into account their environmental impact and performance[15].

BIM software has the capability to integrate with sustainability databases, which offer data on various sustainable materials and products. This may encompass details regarding the embodied carbon of the material, its recyclability, and its energy efficiency. Through accessing this information, designers can promptly assess and appraise sustainable material alternatives that fulfil the project's prerequisites. BIM helps to system to choose materials based on ratings [16].

Moreover, BIM has the potential to facilitate designers in visualising and contrasting various material alternatives in 3D, thereby empowering them to take more knowledgeable decisions. This practice can aid in detecting possible problems like design conflicts or clashes, which can be resolved prior to the commencement of construction. This technology used in Metrorail station project in India [17].

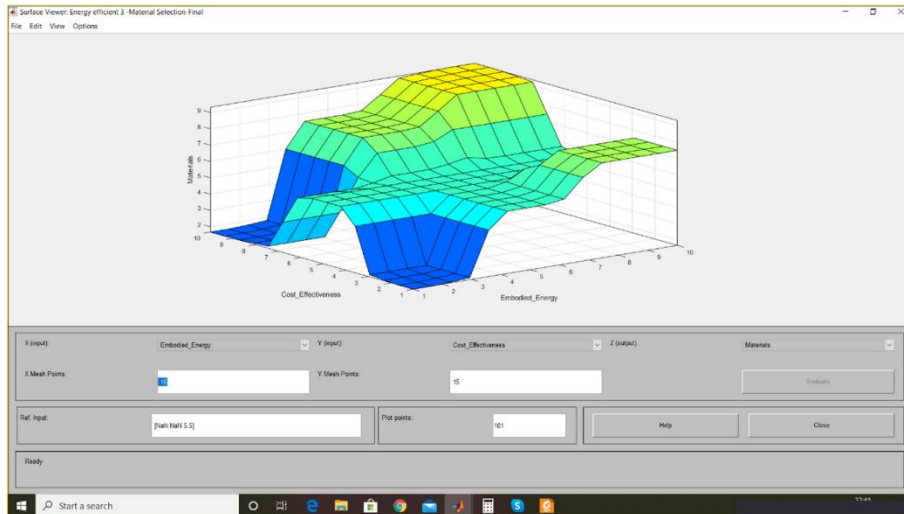


Figure 17: energy efficient materials simulated for cost effectiveness of the project.

Furthermore, BIM has the capability to enhance material utilisation in addition to the selection of sustainable materials. BIM enables precise material quantity tracking from design to construction, resulting in decreased waste production during construction. This can aid in mitigating the environmental impact of the project and lowering expenses linked to waste management. Indoor Environmental Quality: BIM models can be used to analyze indoor environmental quality factors, such as thermal comfort, air quality, and lighting. This information can be used to optimize building design and operation to improve occupant comfort and health [18].

Waste Management: Waste reduction is the third aspect of utilising BIM for implementing and managing sustainability measures. BIM has the potential to decrease construction waste by allowing for precise material estimation and optimisation. BIM enables the identification of potential waste reduction strategies and provides accurate material quantities by tracking materials from the design phase to the construction phase, thereby reducing the amount of waste generated during construction [9a]. In the design phase, Building Information Modelling (BIM) can be utilised to assess the material quantities needed for the project, considering variables such as the building's structural components, orientation, and dimensions. Precisely estimating the amount of materials needed can minimise the chances of excess or insufficient material procurement, thereby mitigating wastage, as per the designers' perspective.

During the commencement of the construction phase, BIM can be employed to monitor the utilisation of materials on-site, furnishing up-to-the-minute information on the amount of materials consumed and the advancement of the project. This can aid in recognising possible problems such as excessive ordering or wastage caused by mistakes or misunderstandings. BIM has the potential to optimise material usage, thereby minimising the chances of wastage. Through material tracking, BIM can offer precise material quantities, facilitating the optimisation of on-site material usage. This approach can effectively reduce the amount of waste produced during construction and lower the expenses related to waste management [19].

BIM has the potential to optimise resource utilisation, including water and energy, while also reducing construction waste. Through simulating the energy consumption and water usage of a building, designers can detect potential areas for enhancement and apply sustainable solutions like renewable energy systems or low-flow faucets and fixtures.

Facility management is the fifth aspect of utilising BIM for executing and overseeing sustainability initiatives. Building Information Modelling (BIM) is a valuable tool for monitoring a building's

sustainability performance in the long run. This allows facility managers to keep track of important metrics such as energy consumption and water usage. BIM is capable of identifying potential areas for sustainability enhancements, such as retrofitting existing buildings or integrating new energy-efficient technologies [20].

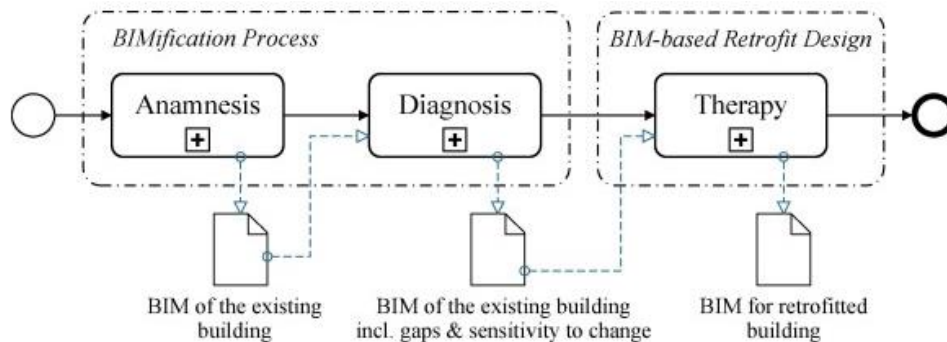


Figure 18:retrofitting strategy

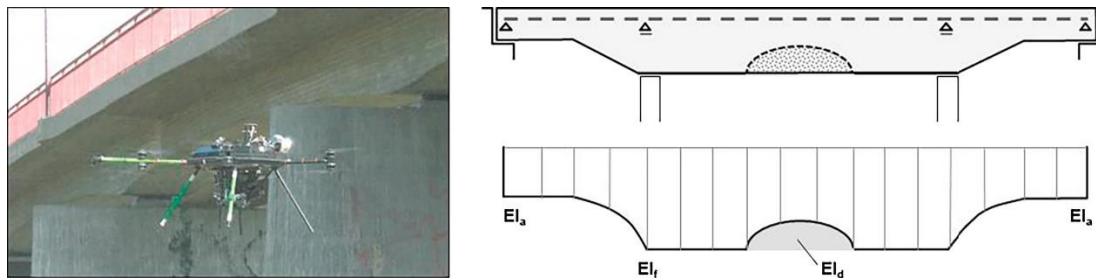


Figure 19:drone scanning a bridge.

After the completion and commencement of a building, BIM can be utilised to gather information on the building's sustainability metrics such as energy consumption and water usage. The data can be utilised to monitor the performance of the building throughout time, pinpointing potential areas for sustainability enhancements.

Through the integration of BIM and building management systems, facility managers can obtain up-to-date information on the building's systems and equipment, allowing them to make knowledgeable decisions regarding maintenance and operation. This may involve managing maintenance schedules, detecting potential problems, and maximizing the utilisation of resources like energy and water.

Moreover, BIM has the potential to pinpoint locations where sustainability enhancements can be implemented. BIM can be utilised to generate a digital representation of the systems and components of an already constructed building. This allows designers and facility managers to recognise possibilities for retrofitting or upgrades. This may involve the incorporation of novel energy-efficient technologies or the integration of sustainable energy alternatives.

BIM is a useful tool for simulating energy consumption and identifying areas for improvement in new construction projects. This may involve optimising building orientation and envelope design, implementing energy-efficient systems, or utilising renewable energy sources.

5.1 Conclusion:

BIM is used to design 3d prototypes of buildings, and UWTSD's SA1 campus buildings are designed for state-of-the-art high computational systems. Issues with software model and original model are identified. Building Information Modelling (BIM) methodologies and digital technologies are used to obtain 'As Designed' and 'As Built' information. Issues such as incorrect geometry of built structure and missing exterior lighting are noticed. Clash detection in Revit enables users to detect and address conflicts between elements within a building model, but MacBook is not compatible for clash automation.

Issues include undetected sanitary objects and non-Sync elements, making it difficult to upgrade or sanitize equipment. Facilities management is a profession that maintains built structures and layouts day-to-day operations and strategic operations to improve the overall health of the building. BIM is a virtual depiction of a structure's design and construction data that can be used to identify potential maintenance issues and develop maintenance plans. BIMXTRA is used to achieve Level 2 BIM, allowing the facilities team and contractor to establish a maintenance schedule based on the identification of each component, system, and equipment in the building and their respective maintenance needs. The integration of a Computerised Maintenance Management System (CMMS) with a Building Information Modelling (BIM) model enables the facilities team and contractor to delegate maintenance responsibilities to staff members or subcontractors based on their availability and skillset.

It also allows the facilities team to prioritize tasks according to their significance and immediacy. The BIM model for reporting is essential for BIM-oriented maintenance management, as it provides insight into maintenance trends and performance, enabling the facilities team to make necessary modifications to the maintenance schedule and enhance maintenance operations. However, there are challenges to effectively utilize BIM outputs in facilities management. BIM requires specialised skills and expertise to be utilised efficiently, and requires efficient communication and collaboration among stakeholders. Implementation and maintenance of BIM can be costly, so facility management teams should evaluate expenses and conduct a cost-benefit analysis.

Facility management teams must integrate BIM with other systems and software to ensure efficient data sharing and streamlined workflows. To achieve interoperability, it is necessary to establish efficient communication, collaboration, and standardization. BIM can be used to implement and improve sustainable measures, such as energy analysis. BIM has the potential to reduce energy consumption, investigate the utilisation of high-efficiency insulation and HVAC systems, and facilitate the selection of sustainable materials during the design phase. It can also be used to visualize and contrast material alternatives in 3D, enabling designers to make informed decisions.

Building Information Modelling (BIM) has the potential to reduce construction waste, improve indoor environmental quality, reduce construction waste, optimise material usage, and optimise resource utilisation. Facility management is the fifth aspect of utilising BIM for sustainability initiatives. BIM is a valuable tool for monitoring a building's sustainability performance, identifying potential areas for sustainability enhancements, and simulating energy consumption in new construction projects. BIM is an important tool for facility management and building information modeling (BIM). It can be used to optimize construction and assembly, optimize material selection, and manage waste. It can also be used to retrofit existing buildings.

6.1 Appendix:

Kier fundamental requirement for Level 2 implementation			P	Planned		
Menu item Planned or Required for the project			R	Required		
Menu item Not Required/Applicable for the project			N	Not Required/Applicable		
BIM Menu Ref No	BIM Menu Item	BIM Menu Description	Pre Contract	Construction	Handover	
Set Up						
KB101	Hardware and Software requirements established	Individual stakeholders to ensure hardware and software requirements are in place.	R	R	R	
KB102	Training strategy in place	Stakeholders to ensure sufficient training for staff. Kier to facilitate BIMXtra specific training.	R	R	R	
KB103	Common Data Environment (CDE) established and maintained	Kier to establish the Common Data Environment as per Section 1.3 , aligned to BS 1192:2007+A2:2016 and PAS 1192-2:2013	R	R	R	
KB104	Data security requirements	Project specific requirements to be addressed if applicable.	R	R	R	
KB105	IP requirements	Project specific requirements to be addressed if applicable.	R	R	R	
KB106	BIM Execution Plan (BEP) developed	As per this document.	R	R	N	
KB107	Project information naming aligned to a common standard	Project information naming within the CDE is to follow BS 1192:2007+A2:2016 code of practice.	R	R	R	
KB108	Work winning activities	Supporting the bid with innovative solutions to enhance the submission		N	N	
Content						
KB201	3D capture of existing conditions	Laser scanning technology used to capture existing conditions. Models may be produced from scans to be included in the PIM.	N	N	N	
KB202	Site location/ context models	Existing buildings and surroundings modelled.	N	N	N	
KB203	Consultant's design models	Design discipline models developed in accordance with this document.	R	R	R	
KB204	Subcontractor / specialist models	Specialist fabrication/installation models incorporated to elevate the design models for construction in accordance with this document.	R	R	R	
KB205	Temporary works models	Temporary structures / items modelled to mitigate coordination risks on site.	N	N	N	

Handover					
KB701	AIM – Asset Information Model required	Design, Construction + OandM information shall captured and associated to model components hosted in the CDE facilitating digital hand over of the asset for use in operation.	R	R	R
KB702	COBie data	COBie shall be a direct output from the CDE utilising the PIM to inform CAFM.	R	R	R
Feedback					
KB801	BIM project performance Reporting	Reports generated from the CDE and used to measure BIM project performance.	R	R	R
KB802	BIM case study authoring	Project BIM successes and lessons learnt shall be captured and shared as case studies.	R	R	R
KB803	Project controls applied from BIM	Project controls and governance gateways shall be implemented using the CDE.	N	P	P
Design					
KB301	Design reviews conducted in a 3D environment	The PIM shall form the medium for discussions at Design Team Meetings (DTMs) and workshops.	R	R	N
KB302	Stakeholder/ client engagement	The PIM shall form the medium for presentation at Client Engagement Meetings (CEMs).	N	R	R
KB303	Drawings created from models	2D drawing sheets generated directly from the BIM models.	R	R	R
KB304	Schedules generated from models	All schedules shall be an output from the PIM hosted in the CDE – either BIMXtra or 4P.	R	R	R
KB305	Room data sheet (RDS) creation	Where there is requirement for RDS, this should be an output from the PIM hosted in the CDE.	N	N	N
KB306	Clash resolution and detection	Proprietary clash detection tools shall be utilised by the Project Team to achieve a fully coordinated design.	R	R	N
KB307	Design change control	Design change control is automatically tracked in the CDE. RFIs can be raised and tracked using the CDE.	P	P	P
KB308	SHE / CDM requirements highlighted	The PIM shall be utilised to mitigate Safety Health and Environment (SHE) risks and to inform SHE inductions.	N	N	N
KB309	Energy analysis using models	Energy modelling and analysis can be integrated into the BIM process.	N	N	N
KB310	Carbon capture to be extracted	Carbon Calculation is an output from the PIM hosted in the CDE.	N	N	N
Commercial					
KB401	Outline cost plan (5D)	The outline cost plan shall utilise high level data generated from BCIS codes against GIFA.	N	N	N
KB402	Detailed cost plan (5D)	The detailed cost plan shall utilise component data generated from the models hosted in the CDE.	N	N	N
KB403	Commercial change control	Commercial reviews shall utilise change control functionality in the CDE.	N	N	N
KB404	Work packaging for procurement	Work Packages shall be generated and procured utilising data from the PIM via functionality in the CDE.	N	N	N
KB405	Whole life costing	Whole life costing measured utilising data generated from the PIM held in the CDE.	N	N	N
Planning					
KB501	Proposed programme simulation (4D)	Programme simulation utilising the PIM via functionality in the CDE.	N	N	N
KB502	Construction programme monitoring (4D)	Programme comparison utilising the PIM via functionality in the CDE.	N	N	N
Construction					
KB601	Waste, recycling and recyclability	Material wastage and recycling calculations shall utilise data generated from the PIM hosted in the CDE.	N	N	N
KB602	Site inductions / animations using models	PIM shall be utilised to enhance site inductions and aid visualisation of the construction process.	N	N	N
KB603	Visual method statements	BIM visualisations shall be utilised to break down complex procedures into visual steps.	N	N	N
KB604	Setting out from models	BIM models and allied technologies can be utilised for setting out purposes.	N	N	N
KB605	Site forms and reports (Field BIM)	Field BIM Apps on mobile devices shall be used with associated workflows to generate, track and close out site forms including RFIs, snags etc.	P	P	P
KB606	Asset tagging (Field BIM)	Data from the field can be captured and associated to model components hosted in the CDE.	N	N	N

Figure 20: Scope of the project laid out by contracto

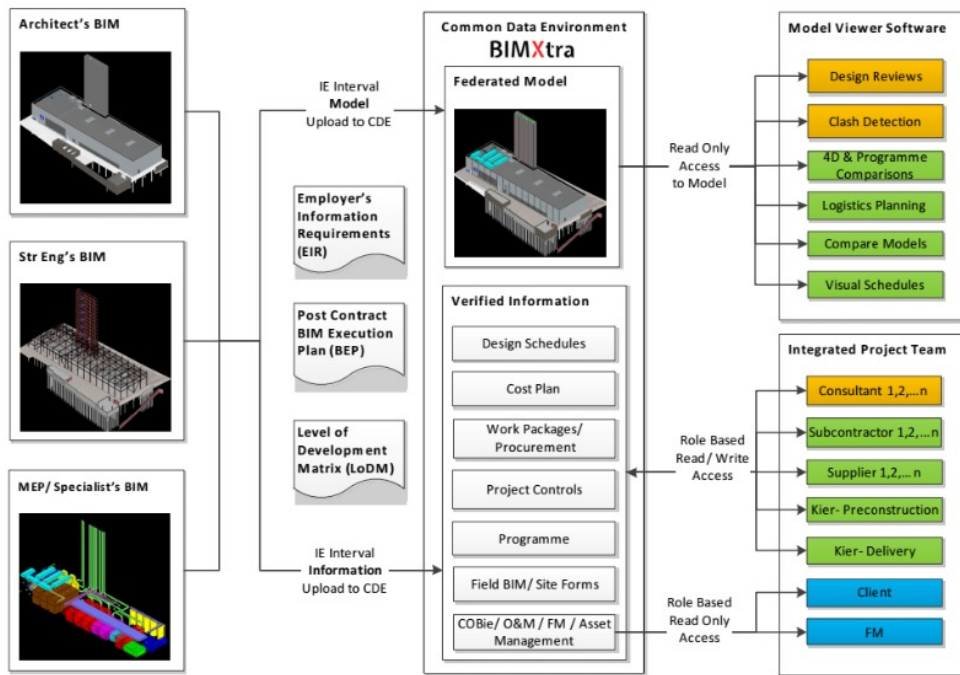


Figure 21:project plan

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