ASSIGNMENT 1
Residential Apartment Construction Project at 526-530 Parnell Road, Auckland

UNITEC INSTITUTE OF TECHNOLOGY

GRADUATE DIPLOMA IN CONSTRUCTION PROJECT MANAGEMENT
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CONS 6102 Virtual Design and Construction

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INTRODUCTION

With Building Information Modelling (BIM) and Digital Technologies (DTs) playing a key role in enhancing project outcomes, the construction sector is undergoing a digital transition. While DTs like drones, laser scanning, IoT sensors, augmented/virtual reality (AR/VR), and digital twins expand the advantages of BIM through improved accuracy, monitoring, visualization, and facility management, BIM offers a collaborative platform that combines design, construction, and operational data into a single model.

This assignment looks at how BIM and DTs were used in the KiwiBuild program's residential apartment complex located at 526–530 Parnell Road in Auckland. To show how these tools assist the objectives of client, contractor, and facility management, the study maps BIM Uses and DT applications across the four major project lifecycle phases—Project Establishment, Design, Construction, and Operation. The ways that BIM and DT Uses facilitate cost control, enhanced collaboration, risk mitigation, sustainability, and long-term operational efficiency are highlighted in particular.

1.0 PROJECT TIMELINE

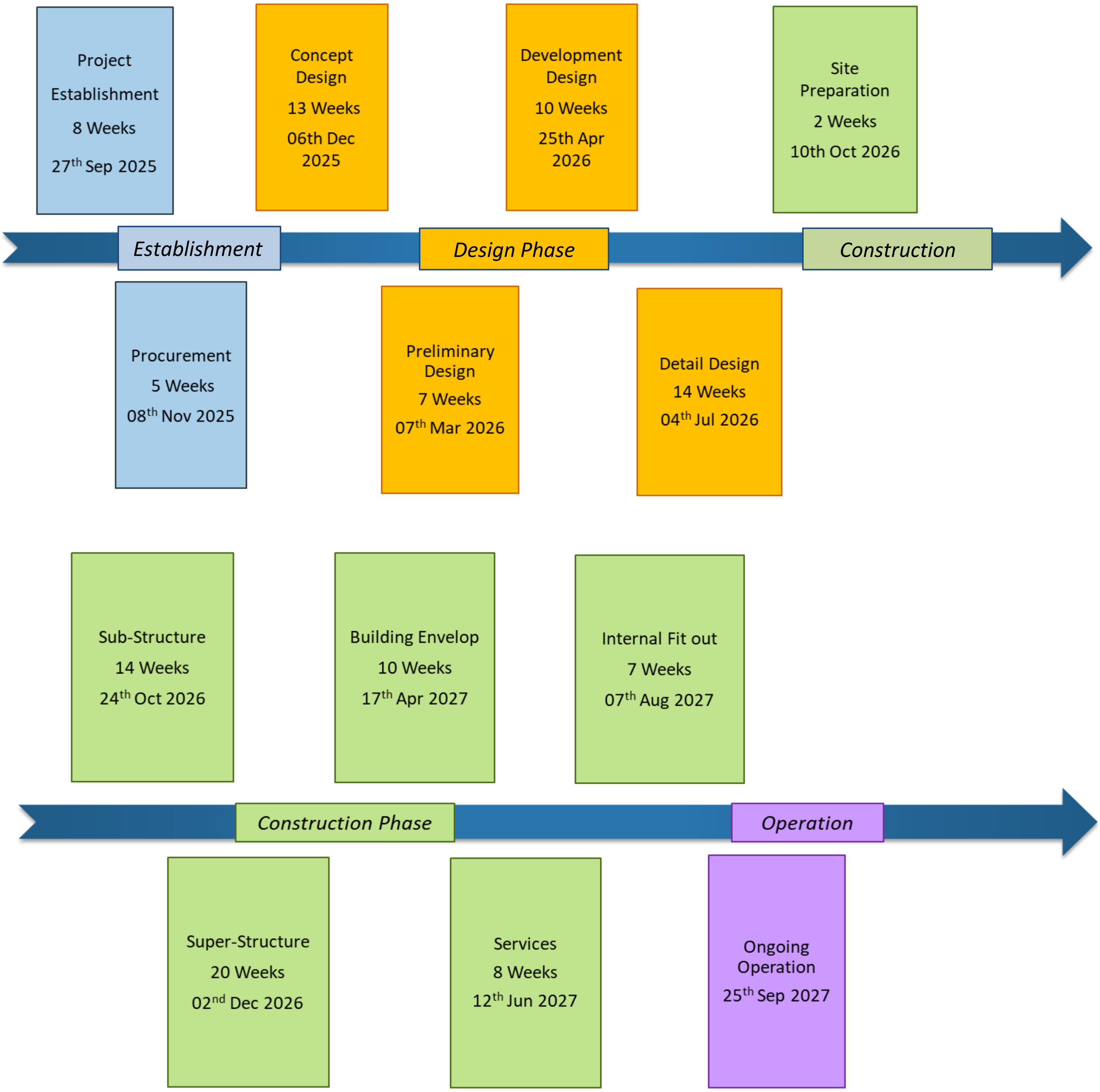

Figure 01: Project Timeline

Pre Design and feasibilityty during the project establishment phase includes acquisition of land, feasibility analysis of project, and common data environment selection for vendors to use for managing all the project BIM data throughout the lifecycle. This phase usually takes around 8 weeks' time. After project establishment, conceptual design with visualization discussing with client and all stakeholders to finalize how the project will be post completion using BIM ensuring the sustainability tests. This phase takes about 13 weeks' time.

Preliminary design phase includes building a model with structural layout and all the MEP integration to determine if there is any overlapping and conflicts that may arise during the construction stage. Takes around 7 weeks' time. After preliminary design applying early clash detection, full design with 3d/4d views, sustainability checks and optimization *to* develop the final design model. This phase may take about 10 weeks' time.

Now the detailed design for the purpose of construction tendering, costing and estimation with Level of development 400 including all BIM information will be completed. The 2d-3d-4d drawings, working drawings, models, using AutoCAD Revit ,Navisworks, with project scheduling , pricing and tendering will be carried out in this phase. This phase may take around 14 weeks months' time as it also includes the council approval and all the documentation required to initiate the project.

The Procurement phase for selection of contractors, awarding the contract to main/subcontractors, vendors and suppliers selection and finalizing takes around 5 weeks' time.

Now entering into the construction stage, demolition, site preparation, site setup, boundary setup, fencing and netting for demolition, top soil removal, debris disposal, waste management planning and all initial may take about 2 weeks' time. The sub structure construction with excavation and foundation construction as per design and specifications takes about 14 weeks depending upon the size, area and type of foundation designs. After ground floor slab is done, superstructure construction including structural frame and slab, exterior walls depending on the designs takes around 20 weeks. Also depends on the procurement plan, types of materials selected, lead time of materials, method of concreting.

All the Building services works Mechanical Electrical Plumbing occurs throughout the construction time from beginning to completion and post completion during the operational lifecycle.

Building envelope phase takes around 10 weeks' time. Interior works finishing, fit out, services takes around 7 weeks' time depending upon level of detailing needed as per design and specifications. After the completion of construction, commissioning, compliance certificate, as built drawings, BIM Level of Development 500, handover, Facility management trainings takes around 14 weeks' time before the project becomes fully functional.

BIM Model used for facilities management, maintenance, operations throught the building lifespan of around 30-50 years time, green star rating and maintenance, continuous monitoring of operations. Overall Project duration from establishment to commissioning takes over 2 years' time and the operational lifecycle will be 30-50 years.

2. BIM USES IN THE PROJECT LIFECYCLE

Building Information Modelling (BIM) is not just a design tool but a methodology that supports collaboration and coordination which helps everyone in a project share information and make better decisions throughout the entire project lifecycle. According to the NZ BIM Handbook, different BIM uses are explained including the activities that that convey value at each stage of project.

BIM can be used in different phases as each BIM Use has a different purpose. By linking the correct BIM to the right project phases, the project can meet all the needs while reducing the risks and delays.

In this section, the most useful BIM software's that matched with the project timeline and how they align to achieve the project goals.

2.1 BIM GOALS:

In a project, the goals change with the Clients and Contractors' perspective. In Client's perspective, the project must priorities sustainability, asset performance along with cost efficiency while Contractor focuses on construct efficiently, clash avoidance and finish on time. By using the respective BIM software, both client and contractor goals can be achieved.

Client BIM Goals:

With the help of BIM software, the Client goals like ensuring accurate cost forecasting, optimizing sustainability and energy efficiency. Also, include ensuring asset data that supports long-term facility management of the project. The main Client goals are explained below:

- ❖ C1: As-built BIM model for the facility management team
- ❖ C2: To get a clear picture and understanding of the facility using 3D virtual model with walk-in video.
- ❖ C3: To understand the construction methodology and progress during the construction work.
- ❖ C4: Optimized design to reduce the operation cost of the project by creating proper timeline and designs without any clash and rework.

- C5: Refers to the goal of client achieving the greater Green Star value through the sustainability evaluation like (Green Star / NABERS).

Contractor BIM Goals:

With the help of BIM software's and the BIM uses, the main contractor's goals can be achieved. From Main Contractor's perspective, there are mainly two areas like in design phase and also in construction phase. As a summary, the main contractor's goal is to reduce rework by early clash detection, cost control through accurate quantity take-off and optimize the construction program with the help of creating 4D sequencing.

Main Contractors Design Goals

- MD1: This refers to generation of optimized design and alternative design solutions if necessary with the help of modelling the existing site conditions after site analysis and through proper spatial programming.
- MD2: This refers to the goal of keeping all the stakeholders fully aware about the progress of each phase of the project by reviewing the design and updating every improvements will be updated and distributed among every stakeholders to avoid clashes with the help of coordinating software's.
- MD3: This is to achieve the goal of building a high star rated project building to achieve the client requirements and also improve the building quality.
- MD4: Refers to achieving the goal of fully reviewed and improvised design which aligns with all the client and other stakeholder's requirements and also ensuring all the cost and scheduling simulation without any clashes.
- MD5: This goal refers to the goal to generating a design for the project ensuring the requirements along with accurate amount of materials needed with the cost using cost estimation and design authoring BIM uses.

Main Contractors Construction Goals

- MC1: This construction goal is to get the updated 4D schedule and monitoring progress to all the stakeholders.
- MC2: This goal is about getting a fully developed model or design with 4D simulation which help the contractors to understand the workflow and reducing the rework or

clash of activities in each phases using BIM.

- MC3: Using the site utilization planning, the contractors can fully utilize the site for the construction works along with keeping the health and safety as first priority as well.
- MC4: Creating the accurate site layout so that they understand where the equipment's are placed and how to utilize the whole area of site along with the excavation works for the timely completion of project with the desired quality.
- MC5: By proper coordinating software's, the contractors can fully utilize the mechanical equipment's while they are available and supporting the timely completion of works.

Facility Management Team Goals:

Pre-construction and construction phases are mainly handled between the clients and the contractors. But once the post-construction or operating phase starts, the whole project should have to be well maintained by the facility management team. They also have some goals to make their work in a scheduled manner. For that they should have the full details of each and every details of the project.

- F1: refers to have all integrated data of the completed project with the help of record modelling and asset management.
- F2: these models and data can be taken as the reference materials for the maintenance and help in finding earlier solution and customer satisfaction.

2.2 SOFTWARE AND TOOLS:

This section focuses on different BIM software which helps to achieve both client and contractor goals in each stage of project life. Each phase has different goals to achieve using different software and tools which are a part of BIM or BIM-related supporting tools.

Software that are BIM tools, which can be used in the project lifecycle to reduce the risk and increase better time management along with clash avoidance. Some of the BIM software and supporting tools which can help in this project during different phases are tabulated below.

- **BIM Software**

Project Phase	**BIM Software**
Pre - Design	Autodesk Civil 3D
Design	Revit, ArchiCAD, Naviswork, Solibri
Construction	Synchro, Navisworks Manage, CostX, Vico
Handover	Revit

- **BIM Related or Supporting Tools**

Project Phase	**BIM supporting tools**
Pre - Design	ArcGIS
Design	IES VE, Sefaira
Handover	COBie
Operations	Archibus, Maximo

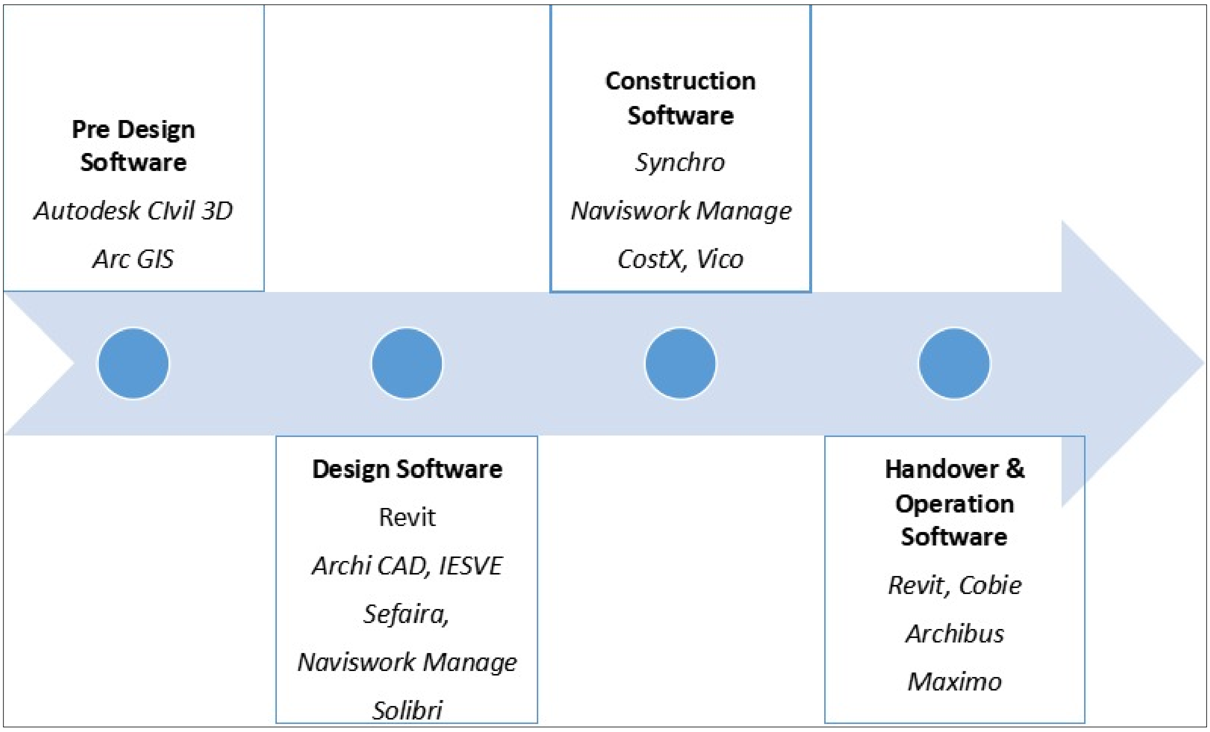

Figure 02: Project Timeline with corresponding software

The above image illustrates the project timeline with corresponding software or tools at each phase which help to keep the accuracy, cost efficiency, sustainability and maintenance of the building.

2.3 CONTRIBUTION TO GOALS:

This section describes how the above-mentioned software and tools help to achieve the client and contractor goals by improving design quality, accurate cost estimates, and construction efficiency. The design tools allow the designers to create coordinated 3D models helping the Client to visualize them before construction and incorporate early design change to keep the project accuracy.

Coordination tools help to avoid clashes before the construction reducing the rework and manage cost accuracy. Scheduling and estimating software help to create the 4D and 5D details of project, helping the clients and contractors to know the most effective construction sequences and preparing the accurate bids.

Collaboration software helps in the live monitoring of project phases, keeping all stakeholders connected. At handover and operations, some software links the building data to asset management to ensure the accurate as-built information helps the clients in maintaining and operating the building. Finally, digital technologies add value by enhancing, safety and monitoring the building efficiency with the help of proper maintenance.

PROJECT PHASE	BIM USE	SOFTWARE / TOOLS	CONTRIBUTION TO GOALS
Pre - Design	Site Analysis	Autodesk Civil 3D, ArcGIS	• Support informed site selection • Reduces risk
Concept Design	Design Authoring	Revit, ArchiCAD	Provides visual experience to Client
Developed Design	Energy Analysis	IES VE, Sefaira	Ensures Sustainability
Detailed Design	Clash Detection	Naviswork, Solibri	• Reduces rework • Reduces cost overruns
Construction	4D Simulation	Synchro, Navisworks Manage	Ensures milestones and sequencing of project
	Estimation	CostX, Vico	• Accurate budgeting • Reduces disputes
Handover	As-Built Models	Revit COBie	Ensure the accuracy of linked building data to asset management
Operations	Integrated Facilities Management	Archibus, Maximo	Enables lifecycle maintenance planning

In conclusion, these software or tools provide accurate cost, time, and quality whereas for contractors get the efficiency and risk reduction for the timely completion of the building.

Below are the software or tools which can be used in this project along with its contribution to the specified phase.

Role	Main Goal	BIM Uses (According to the NZ BIM Appendix D)	Project Establishment	Procurement	Concept Design	Preliminary Design	Development Design	Detail Design	Site Preparation	Sub-Structure	Super-Structure	Building Envelop	Services	Internal Fit out	Ongoing Operation
Client (Kiwi Build)	C1. As-built BIM model for the facility management team.	16. Record Modelling							✓	✓	✓	✓	✓	✓	✓
		17. Asset Management													✓
		18. Building Maintenance Scheduling													✓
		20. Space Management & Tracking			✓	✓	✓	✓							✓
	C2. To get a clear picture and understanding of the facility via a 3D walk-in, a virtual model.	1. Existing Condition Modelling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		4. Spatial Programming	✓	✓	✓	✓	✓	✓							✓
		6. Design Review			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		7. Design Authoring			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	C3. To understand the construction methodology and progress during the construction work. (Sustainability) rating.	3 Phase Planning (4D Modelling)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		12. Site Utilisation Planning							✓	✓	✓	✓	✓	✓	
		13. Construction System Design			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	C4. Optimised design to reduce operation cost.	2. Cost Estimation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		8. Engineering Analysis			✓	✓	✓	✓							
		9. Sustainability Evaluation			✓	✓	✓	✓							
		12. Site Utilisation Planning							✓	✓	✓	✓	✓	✓	
		19. Building System Analysis													✓
	C5. Achieve Green Star	8. Engineering Analysis			✓	✓	✓	✓							
		9. Sustainability (Green Star/NABERS) Evaluation			✓	✓	✓	✓							
		19. Building System Analysis													✓
Main Contractor's	MD1: Optimised design and generated alternative design solutions.	1. Existing Condition Modelling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		4. Spatial Programming	✓	✓	✓	✓	✓	✓							✓
		5. Site Analysis	✓	✓	✓	✓	✓	✓							
		7. Design Authoring			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MD2: Improved collaboration between different stakeholders. with no clash.	6. Design Review			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		11. 3D Coordination			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		13. Construction System Design			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Role	Main Goal	BIM Uses (According to the NZ BIM Appendix D)	Project Establishment	Procurement	Concept Design	Preliminary Design	Development Design	Detail Design	Site Preparation	Sub-Structure	Super-Structure	Building Envelop	Services	Internal Fit out	Ongoing Operation
Main Contractor's	MD3: Sustainability and engineering analysis for optimised design to reduce operation cost.	8. Engineering Analysis			✓	✓	✓	✓							
		9. Sustainability (Green Star/NABERS) Evaluation			✓	✓	✓	✓							
		12. Site Utilisation Planning							✓	✓	✓	✓	✓	✓	
	MD4: Final design	6. Design Review			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		10. Code Validation			✓	✓	✓	✓							
		11. 3D Coordination			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MD5: Accurate quantity and cost calculation.	2. Cost Estimation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		7. Design Authoring			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MC1. 4D schedule & monitor progress	3 Phase Planning (4D Modelling)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		12. Site Utilisation Planning							✓	✓	✓	✓	✓	✓	
	MC2. Use BIM for fabrication	14. Digital Fabrication							✓	✓	✓	✓	✓	✓	
		13. Construction System Design			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MC3. Site logistics, cranes & safety	12. Site Utilisation Planning							✓	✓	✓	✓	✓	✓	
		13. Construction System Design			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MC4. Accurate site layout / excavation	1. Existing Condition Modelling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		15. 3D Control & Planning							✓	✓	✓	✓	✓	✓	
	MC5. Quality of mechanical components	11. 3D Coordination			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		16. Record Modelling							✓	✓	✓	✓	✓	✓	✓
Facility Management Team	F1. Integrate as-built data with BMS	16. Record Modelling							✓	✓	✓	✓	✓	✓	✓
		17. Asset Management													✓
		19. Building System Analysis													✓
	F2. Use as-built model for maintenance	17. Asset Management													✓
		18. Building Maintenance Scheduling													✓
		20. Space Management & Tracking			✓	✓	✓	✓							✓
		21. Disaster Planning													✓

3. DIGITAL TECHNOLOGIES IN THE PROJECT LIFECYCLE

3.1 DT USES AND GOALS

Digital technologies (DTs) play an important role in enhancing efficiency, cooperation, and innovation across the life cycle of modern construction projects. Building Information Modelling (BIM) is enhanced with DTs, which offer sophisticated tools for data collection, analysis, and real-time communication for the KiwiBuild residential apartment complex located at 526-530 Parnell Road in Auckland. To ensure that the contractor's goals such as optimized design (MD1), improved safety (MC3), and accurate progress monitoring (MC1) as well as the client's goals such as achieving clear visualization (C2), lowering operational costs (C4), and obtaining a Green Star rating (C5) are met, their application must be examined methodically throughout the design, construction, and operation phases. This section lists the most appropriate tools and platforms, describes the main DTs used at each stage of the project, and illustrates how these technologies directly serve the stated goals of the customer and the contractor.

Estimation Phase

Digital solutions provide precise and transparent cost and resource forecasts during the estimating phase. Based on past project data, market trends, and material availability, contractors can produce accurate projections with the help of cloud-based estimation tools and AI-driven predictive analytics. Digital dashboards guarantee collaboration (MD2) and lower financial risks by integrating financial data from various stakeholders in real time.

By correctly quantifying the demolition and preparation requirements, laser scanning and photogrammetry can improve cost certainty by capturing the site's current state (MD5). Furthermore, the customer can compare design solutions for long-term efficiency using sustainability analysis platforms (such energy modeling tools and carbon footprint calculators), which directly supports lower operating costs (C4) and the Green Star rating (C5).

Role	Main Goal	Digital Technologies	
		Project Establishment	Procurement
Client (Kiwi Build)	C1. As-built BIM model for the facility management team.	NA	CDE
	C2. To get a clear picture and understanding of the facility via a 3D walk-in, a virtual model.	Drone/Laser Scan	VR/AR Concept Viz
	C3. To understand the construction methodology and progress during the construction work. (Sustainability) rating.	NA	NA
	C4. Optimised design to reduce operation cost.	GIS/Site Analysis	Cost DB
	C5. Achieve Green Star	NA	NA
Main Contractor's	MD1: Optimised design and generated alternative design solutions.	GIS/Laser Scan	NA
	MD2: Improved collaboration between different stakeholders with no clash.	CDE	CDE
	MD3: Sustainability and engineering analysis for optimised design to reduce operation cost.	Sustainability tools	NA
	MD4: Final design	NA	NA
	MD5: Accurate quantity and cost calculation.	NA	5D Estimating
	MC1. 4D schedule & monitor progress	NA	NA
	MC2. Use BIM for fabrication	NA	NA
	MC3. Site logistics, cranes & safety	Drone Survey	NA
	MC4. Accurate site layout / excavation	GPS/Survey	NA
	MC5. Quality of mechanical components	NA	NA
Facility Management Team	F1. Integrate as-built data with BMS	NA	NA
	F2. Use as-built model for maintenance	NA	NA

Design Phase

During the design phase, digital technologies offer a solid basis for accuracy, teamwork, and informed decision-making. To ensure that the digital model accurately depicts the real-world environment, 3D laser scanning and reality capture are used to precisely document actual site conditions prior to destruction. This minimizes mistakes, cuts down on rework, and helps the contractor achieve their objective of creating an optimized design (MD1). The client's goal of acquiring a clear understanding of the facility is also met by delivering correct as-built documentation (C2). Furthermore, by enabling stakeholders to virtually "walk through" the suggested design, augmented and virtual reality (AR/VR) platforms increase communication and facilitate better decision-making. This immediately supports the contractor's goal of better inter-disciplinary collaboration (MD2) and the client's goal of achieving a complete understanding of the facility (C2). When taken as a whole, these DTs guarantee that the design process is open, well-coordinated, and in line with project objectives.

Role	Main Goal	Digital Technologies			
		Concept Design	Preliminary Design	Development Design	Detail Design
Client (Kiwi Build)	C1. As-built BIM model for the facility management team.	CDE	CDE	Record Model Prep	As-Built Prep
	C2. To get a clear picture and understanding of the facility via a 3D walk-in, a virtual model.	VR/AR Concept Viz	VR/AR Concept Viz	VR/AR Concept Viz	VR/AR Concept Viz
	C3. To understand the construction methodology and progress during the construction work. (Sustainability) rating.	NA	4D Simulation	4D Simulation	4D Detailed Sim
	C4. Optimized design to reduce operation cost.	Energy Simulation	5D Estimation	5D Estimation	5D Estimation
	C5. Achieve Green Star	Sustainability Simulation	Energy Sim	Energy Sim	Energy Sim

Role	Main Goal	Digital Technologies			
		Concept Design	Preliminary Design	Development Design	Detail Design
Main Contractor's	MD1: Optimised design and generated alternative design solutions.	Laser Scan Input	Parametric Design Tools	NA	NA
	MD2: Improved collaboration between different stakeholders with no clash.	CDE, VR	VR/CDE	CDE	CDE
	MD3: Sustainability and engineering analysis for optimised design to reduce operation cost.	Sustainability Sim	Energy Tools	Sustainability tools	Energy Tools
	MD4: Final design	Early Clash Tools	Navisworks Clash	Clash Detection	Navisworks Clash
	MD5: Accurate quantity and cost calculation.	NA	Candy CCS	Candy CCS	Candy CCS
	MC1. 4D schedule & monitor progress	NA	4D Simulation	4D Simulation	4D Simulation
	MC2. Use BIM for fabrication	NA	NA	NA	Digital Fabrication Models
	MC3. Site logistics, cranes & safety	NA	NA	NA	NA
	MC4. Accurate site layout / excavation	NA	NA	NA	GPS Layout
	MC5. Quality of mechanical components	NA	NA	NA	AR QA/QC Prep
Facility Management Team	F1. Integrate as-built data with BMS	NA	NA	NA	NA
	F2. Use as-built model for maintenance	NA	NA	NA	NA

Construction Phase

During the construction phase, DTs prioritize project execution, progress monitoring, and site safety. By combining the 3D model with time-based schedules, 4D simulation and sequencing facilitates better sequencing management and progress monitoring for contractors (MC1) while giving clients an easily comprehensible visual representation of the construction process (C3). IoT sensors and wearable devices boost operational safety and efficiency by tracking equipment, monitoring worker health, and delivering real-time environmental data. These solutions lower risks and directly support the contractor's objective of enhancing on-site safety (MC3). Furthermore, drone surveys and robotic total stations assist with accurate progress tracking and site layout. Robotic total stations guarantee exact excavation and layout operations, supporting the contractor's objective of precise site setting (MC4), while drones provide aerial imagery and status updates, assisting the client in tracking development (C3). These technologies work together to provide transparent, safe, and effective construction operations.

Role	Main Goal	Digital Technologies					
		Site Preparation	Sub-Structure	Super-Structure	Building Envelop	Services	Internal Fit out
Client (Kiwi Build)	C1. As-built BIM model for the facility management team.	NA	NA	NA	Record Model Update	Record Model Update	Record Model Update
	C2. To get a clear picture and understanding of the facility via a 3D walk-in, a virtual model.	NA	NA	NA	NA	AR/VR Review	VR Walkthrough
	C3. To understand the construction methodology and progress during the construction work. (Sustainability) rating.	Drones (progress start)	4D Simulation + Drones	4D Simulation + Drones	4D Visualisation	4D Services Phasing	4D Fit-out Sequencing
	C4. Optimised design to reduce operation cost.	NA	NA	NA	Energy Sim	NA	NA
	C5. Achieve Green Star	NA	NA	NA	Energy Sim	Energy Monitoring	NA
Main Contractor's	MD1: Optimised design and generated alternative design solutions.	Site Preparation	Sub-Structure	Super-Structure	Building Envelop	Services	Internal Fit out
	MD2: Improved collaboration between different stakeholders with no clash.	NA	NA	NA	CDE	CDE	CDE
	MD3: Sustainability and engineering analysis for optimised design to reduce operation cost.	NA	NA	NA	Energy Tools	Energy Tools	NA

	MD4: Final design	NA	NA	Clash Detection	Clash Detection	Clash Detection	Clash Detection
	MD5: Accurate quantity and cost calculation.	NA	NA	NA	NA	Candy CCS	NA
	MC1. 4D schedule & monitor progress	4D Simulation	4D Simulation	4D Simulation	4D Simulation	4D Simulation	4D Simulation
	MC2. Use BIM for fabrication	NA	NA	Digital Fabrication (prefab)	Fabrication (Façade)	Prefab MEP modules	Prefab MEP modules
	MC3. Site logistics, cranes & safety	Drone Site Logistics	NA	Drones, Sensors	Site Sensors	Site Logistics Tools	Drones, Sensors
	MC4. Accurate site layout / excavation	GPS Layout	GPS Layout	GPS Layout	GPS Layout	GPS Layout	GPS Layout
	MC5. Quality of mechanical components	NA	NA	AR QA/QC Prep	AR QA/QC Prep	AR QA/QC Prep	AR QA/QC Prep
Facility Management Team	F1. Integrate as-built data with BMS	NA	NA	NA	NA	IoT Integration	IoT Integration
	F2. Use as-built model for maintenance	NA	NA	NA	NA	CMMS	CMMS

Operation and Facility Management Phase

During the operations phase, DTs make sure the building is economical, sustainable, and efficient for the duration of its life. Through the use of digital twins, facility managers may visualize building performance in real time by connecting the as-built BIM model with real-time operational data streams. Facilities management goals F1 and F2 are directly addressed by this technology, which also simplifies maintenance planning and integrates with building management systems. Reducing long-term running costs is another goal that digital twins assist the client in achieving (C4). By continuously monitoring occupancy, HVAC performance, and energy usage, IoT-enabled smart building systems also assist the client in achieving their sustainability objective of obtaining a Green Star rating (C5). Lastly, F2 directly benefits from the structured asset monitoring, maintenance scheduling, and lifecycle management capabilities provided by Computer-Aided Facility Management (CAFM) and Computerized Maintenance Management Systems (CMMS). For as long as the apartment complex is in operation, these DTs make sure it remains sustainable, reasonably priced, and operational.

Role	Main Goal	DT's Ongoing Operations
Client (Kiwi Build)	C1. As-built BIM model for the facility management team.	As-Built Model Handover
	C2. To get a clear picture and understanding of the facility via a 3D walk-in, a virtual model.	VR/AR FM Walkthrough
	C3. To understand the construction methodology and progress during the construction work. (Sustainability) rating.	NA
	C4. Optimized design to reduce operation cost.	IoT Sensors (cost efficiency)
	C5. Achieve Green Star	Energy Monitoring (NABERS)
Main Contractor's	MD1: Optimized design and generated alternative design solutions.	NA
	MD2: Improved collaboration between different stakeholders with no clash.	NA
	MD3: Sustainability and engineering analysis for optimized design to reduce operation cost.	IoT Sustainability

	MD4: Final design	NA
	MD5: Accurate quantity and cost calculation.	NA
	MC1. 4D schedule & monitor progress	4D Simulation
	MC2. Use BIM for fabrication	NA
	MC3. Site logistics, cranes & safety	NA
	MC4. Accurate site layout / excavation	GPS Layout
	MC5. Quality of mechanical components	NA
Facility Management Team	F1. Integrate as-built data with BMS	FM Systems (BMS/CMMS
	F2. Use as-built model for maintenance	CMMS

During every step of estimation, design, building, and operation, digital technologies provide an integrated system that enhances accuracy, collaboration, safety, efficiency, and sustainability. In addition to ensuring that the client's objectives clear visualization, reduced running costs, and environmental certification are fulfilled, they assist the contractor in achieving ideal design, safe construction, and efficient progress monitoring. The KiwiBuild project maximizes long-term value and produces innovative, sustainable, and future-ready products by carefully aligning DTs with both parties' objectives.

3.2 SOFTWARE AND TOOLS

Determining the appropriate tools and connecting them with the project phases and stakeholder objectives are essential for the successful use of digital technologies (DTs) in the KiwiBuild residential unit project. By identifying suitable devices and platforms, both the client (KiwiBuild) and the contractor (Alpha Developers) may improve efficiency, safety, and environmental sustainability. An organized overview of the main DTs, their supporting tools and software, the project period in which they are implemented, and the particular client, contractor, and facility management objectives they cover is provided in the following table.

Digital Technology	Tools / Software	Project Phase	Goals Supported
3D Laser Scanning & Reality Capture	FARO Focus 3D, Leica BLK360, Matterport Pro3,	Design	Accurate site capture (MD1), clear facility understanding (C2)
AR/VR Walkthroughs	Enscape, Twinmotion, Unity Reflect, HTC Vive, Oculus Quest	Design	Enhanced client visualization (C2), improved collaboration among stakeholders (MD2)
Cloud Collaboration / CDE	Procore, Aconex, Microsoft SharePoint	Design	Centralized data sharing (MD2), clash-free design coordination (MD4)
4D Simulation & Sequencing	Primavera P6, Microsoft Project (MS Project), Oracle Construction Intelligence Cloud	Construction	Construction methodology visualization (C3), progress monitoring and scheduling (MC1)
IoT Sensors & Wearables	Trimble CrewSight, DAQRI Smart Helmets, Spot-r by Triax	Construction	Worker safety and hazard detection (MC3), real-time quality monitoring (MC5)
Drone Surveys	DJI Phantom 4 RTK, DJI Mavic 3 Enterprise, Pix4D, DroneDeploy	Construction	Aerial progress tracking (C3), accurate logistics planning and excavation layout (MC4)

Digital Technology	Tools / Software	Project Phase	Goals Supported
Robotic Total Stations	Trimble RTS Series, Leica iCON iCR70	Construction	Precise site layout (MC4), installation verification and quality assurance (MC5)
Digital Twins	Azure Digital Twins, Siemens Navigator, Autodesk Tandem	Operation	Integration with BMS (F1), optimised facility performance and cost reduction (C4)
IoT-enabled Smart Building Systems	Schneider EcoStruxure, Honeywell Forge	Operation	Energy efficiency and sustainability compliance (C5), real-time occupancy and HVAC monitoring (C5)
CAFM/CMMS Systems	IBM Maximo, Archibus, Planon	Operation	Facility maintenance management (F2), lifecycle optimisation and operational cost reduction (C4)

The value of software in supporting project delivery is demonstrated by the way digital technologies are mapped to tools, phases, and goals. 3D scanning, AR/VR, and cloud collaboration platforms are examples of tools that improve clarity, precise data, and cooperation during the design phase. Construction safety, progress tracking, and precise execution are ensured by technologies like drones, robotic total stations, IoT sensors, and 4D simulation. Finally, digital twins, smart building systems, and CAFM/CMMS platforms provide long-term performance and effective asset management during the operational phase. In addition to assisting the client, contractor, and facility management team in accomplishing their goals, these tools ensure that the project will be finished precisely, effectively, and with long-term operational value.

3.3 CONTRIBUTION TO GOALS:

The incorporation of digital technology (DTs) across the KiwiBuild residential unit project directly contributes to accomplishing both client and contractor goals. By enhancing precision, safety, teamwork, effectiveness, and sustainability at various phases of the project lifecycle, each DT contributes quantifiable value.

In the design phase, technologies such as 3D laser scanning and visualization tools (such FARO Focus and Leica BLK360) provide a strong foundation for design and collision detection. This reduces rework and cost overruns while also enabling objectives such as an accurate as-built model (C1) and optimum design solutions (MD1, MD4). Through AR/VR walkthroughs, clients can visually experience places utilizing systems such as Enscape or Twinmotion, meeting the goals of clear visualization (C2) and better cooperation (MD2). This expedites design approvals and enhances spatial understanding. Cloud-based collaboration solutions, such as Procore, further facilitate design coordination by maintaining a single source of truth, ensuring that all stakeholders have access to consistent data, and reducing errors.

During the planning, carrying out, and monitoring phases of the building process, DTs are quite beneficial. To visualize the process, identify sequencing issues, and track progress against the timeline, 4D simulation tools such as Primavera P6 and Oracle Construction Intelligence Cloud combine time and cost data with the BIM model. This immediately contributes to the goals of transparency monitoring (MC1) and methodology comprehension (C3). IoT sensors and wearables help contractors achieve their goals for better safety (MC3) and quality verification (MC5). They increase worker safety by alerting teams to possible hazards and monitoring conditions in real-time. Drone surveys, such as the DJI Phantom with Pix4D, improve excavation accuracy and progress reporting by offering quick site progress reports, orthomosaics, and volumetric computations (MC4, C3). In the meantime, very precise planning and installation are made possible by robotic total stations, which reduce errors and guarantee component placement, enhancing manufacturing quality and site logistics (MC4, MC5).

During the operating phase, DTs provide the client and facility management (FM) team with long-term value. Digital twins developed from as-built BIM and live sensor data allow for performance monitoring, predictive maintenance, and scenario testing. In addition to improving sustainability performance (C5) and lowering lifespan costs (C4), this also connects with building management systems to facilitate operations (F1). By optimizing consumption of energy through continuous evaluation, IoT-enabled smart building systems (like Schneider Electric EcoStruxure) support customer objectives for conservation and lower operational costs (C4, C5). Subsequently, CAFM/CMMS software including IBM Maximo facilitates structured asset management, preventative maintenance, along with effective work-order administration, allowing the Facilities Management (FM) staff to successfully manage the building utilizing accurate as-built data (C1, F2).

In conclusion, these digital technologies add value by transforming unstructured data into actionable insights and processes. Long-term efficiency improvement, reliable and efficient construction, immersive client interaction, and precise asset collection are all made possible by them. Together, they ensure that the project achieves the customer's primary goals of accuracy, clarity, sustainability, and operational effectiveness, as well as the contractor's objectives of collaboration, safety, cost management, and quality assurance.

4. STAKEHOLDER ROLES IN BIM AND DT

The effectiveness of a contemporary construction project relies significantly on strong collaboration among various stakeholders throughout the project lifecycle. Building Information Modeling (BIM) and Digital Technologies (DT) lay the groundwork for information integration, facilitating informed choices and maintaining quality during the design, construction, and operation phases of buildings. This section details the main stakeholders involved in the KiwiBuild Residential Apartment Project on Parnell Road, Auckland, and clarifies their functions in various stages of the project, the BIM Uses linked to them, and the Digital Technology tools they support

4.1 STAKEHOLDERS BY PHASE

The project phases of the New Zealand Construction Industry Council (NZCIC) offer a coherent framework to outline stakeholder participation. At a broad level, the key stakeholders consist of the Client (KiwiBuild), Developer (Alpha Developers), Design Consultants (Architects, Engineers, Sustainability experts), Cost Consultant, Main Contractor (Alpha Contractor), Subcontractors and Fabricators, Facility Management Team, and Regulatory Bodies.

- **Establishment:** Client (KiwiBuild), Developer/PM (Alpha Developers), Regulatory Authorities, BIM Contractor, Cost Consultant
- **Procurement:** Client (KiwiBuild), Developer/PM (Alpha Developers), Main Contractor, BIM Contractor, Cost Consultant
- **Design Phases (Concept)**: Client, Developer/PM, Design Consultants, BIM Contractor, Cost Consultant
- **Design Phases (Preliminary)**: Client, Developer/PM, Design Consultants, Regulatory Authorities, BIM Contractor, Cost Consultant
- **Design Phases (Developed)**: Client, Developer/PM, Design Consultants, Contractor (early involvement), BIM Contractor, Regulatory Authorities
- **Design Phases (Detailed)**: Client, Developer/PM, Design Consultants, Main Contractor, Subcontractors, BIM Contractor, Cost Consultant
- **Construction Phase:** Main Contractor, Subcontractors, Design Consultants, BIM

Contractor, Client (monitoring)

- **Handover and Operations Phase:** Facility Management Team, Client, BIM Contractor (handover support)

The above sequencing emphasizes that varying stakeholders engage at different levels based on the phase, yet communication among them should always remain smooth.

Establishment	Design	Construction	Operation
• Client • Developer • Regulatory Authorities • BIM Contractor • Cost Consultant • Main Contractor	• Client • Developer • Regulatory Authorities • Design Consultant • BIM Contractor • Cost • Consultant • Main Contractor	• Main Contractor • Sub contractors • Design Consultant • BIM Contractor • Client	• Facility Management Team • Client • BIM Contractor

Figure 03: Stakeholders involvement in major four phases

4.2 BIM ROLES PER STAKEHOLDER

BIM Uses, as defined in the NZ BIM Handbook Appendix D, play an important role in clarifying how each stakeholder contributes to the project. The table below shows the mapping of stakeholders, BIM Uses, and their responsibilities:

Phase	Stakeholder	BIM Use (Appendix D)	Role in BIM Use
Establishment	Client (KiwiBuild)	1. Existing Conditions Modelling 4. Spatial Programming	Define site data requirements, approve spatial needs.
	Developer / PM	5. Site Analysis	Lead feasibility assessment.
	BIM Contractor	1. Existing Conditions Modelling	Establish BIM standards and BEP.
	Cost Consultant	5. Site Analysis	Advise on financial feasibility.
Procurement	Developer / PM	3. Phase Planning	Manage BIM-linked programme.
	Main Contractor	2. Cost Estimation 3. Phase Planning	Use BIM-based estimates, link programme to tender.
	Cost Consultant	2. Cost Estimation	Validate tender costs from BIM.
	BIM Contractor	3. Phase Planning	Ensure BIM data supports procurement.
Design (Concept → Detailed)	Client	6. Design Review 9. Sustainability Evaluation 8.Facility Energy Analysis 11. 3D Coordination	Validate design options in 3D, set sustainability/energy targets, and approve coordinated design.
	Developer / PM	11. 3D Coordination	Oversee multidisciplinary integration.

	Design Consultants	6. Design Review 7. Design Authoring 8. Engineering Analysis (Structural Analysis) (Facility Energy Analysis) 11.3D Coordination 10.Code Validation 13. Construction System Design	Author design models, run structural/energy analyses, coordinate disciplines, validate codes, and prepare constructability mock-ups.
	Cost Consultant	7. Design Authoring 8. Structural Analysis	Extract BIM quantities for cost planning, review structural cost impact.
	BIM Contractor	6. Design Review 11. 3D Coordination	Facilitate review, run clash detection workshops.
	Regulatory Authorities	11.3D Coordination 10. Code Validation	Review coordinated design, validate compliance.
Construction	Main Contractor	3.Phase Planning 12.Site Utilisation Planning 13.Construction System Design 14.Digital Fabrication 15. 3D Control & Planning 16. Record Modelling	Manage 4D programme, plan logistics and constructability, produce fabrication drawings, apply digital layout, update as-built.
	Subcontractors	14. Digital Fabrication 15. 3D Control & Planning 16. Record Modelling	Produce prefabrication models, apply layout on site, feed installed data into as-built model.
	BIM Contractor	16. Record Modelling	Manage integration of construction data into record model.
	Client	3. Phase Planning	Monitor progress via 4D BIM.

Operation	Facility Management Team	16.Record Modelling 17.Asset Management 18. Preventative Maintenance 19. Building Systems Analysis 20. Space Management 21. Disaster Planning	Receive as-built BIM, link assets to FM systems, use BIM for maintenance, performance, occupancy, and emergency planning.
	Client	17. Asset Management	Ensure lifecycle goals achieved.
	BIM Contractor	17. Asset Management	Support handover of FM-ready BIM.

The content of the above table guarantees that BIM is not limited to design coordination but also encompasses construction and facility management, providing value throughout the lifecycle.

4.3 DT ROLES PER STAKEHOLDER

Digital Technologies (DT) enhance BIM's potential by offering sophisticated tools for simulation, visualization, monitoring, and management. Stakeholders depend on various DT applications throughout each phase of the project. The table beneath highlights these:

Phase	Stakeholder	DT Use	Role in DT Use
Establishment	Client	AR/VR walk-throughs	Validate early design vision.
	Developer / PM	CDE setup, dashboards	Establish governance and reporting.
	Cost Consultant	Benchmarking tools	Assess cost feasibility.
	BIM Contractor	BEP tools; CDE hosting	Prepare BIM Execution Plan; host data.
Procurement	Client	Dashboards	Monitor procurement options.
	Developer / PM	Collaboration platforms	Coordinate procurement data.
	Main Contractor	BIM-enabled dashboards	Prepare digital tenders.
	Cost Consultant	e-Procurement portals	Validate bids.
	BIM Contractor	Digital dashboards	Ensure tender aligns with BIM BEP.
Design (Concept → Detailed)	Client	VR/AR design reviews	Validate design concepts and sustainability options.
	Developer / PM	Cloud dashboards	Track design progress and KPIs.
	Design Consultants	Generative design tools Simulation software (energy, CFD, daylight) VR/AR validation	Explore alternatives, optimise performance, present immersive design options.
	Cost Consultant	5D BIM cost dashboards	Update evolving cost plans.
	BIM Contractor	Clash detection software	Run digital coordination checks.

	Regulatory Authorities	Automated code-checking; e-submission portals	Validate compliance digitally.
Construction	Main Contractor	Drones, IoT sensors, AR-assisted installation, dashboards	Monitor progress (drones/IoT), improve accuracy (AR), report KPIs.
	Subcontractors	CNC fabrication, 3D printing, AR layout	Prefabricate elements, use AR for layout accuracy.
	BIM Contractor	CDE dashboards, integration tools	Ensure construction data captured in real time.
	Client	Dashboards	Track progress digitally.
Operation	Facility Management Team	Digital Twin, CMMS, mobile FM apps	Integrate BIM with IoT, manage maintenance, carry out daily FM tasks.
	Client	IoT-enabled dashboards	Monitor lifecycle KPIs.
	BIM Contractor	Digital Twin integration	Support transition of BIM to FM systems.

By incorporating these DT uses, stakeholders improve efficiency, minimize errors, and attain increased transparency throughout the project's lifecycle.

5. CONCLUSION

According to the report, digital technologies and BIM are essential for completing projects in a way that is effective, cooperative, and sustainable. The project gains from matching contractor and customer goals with BIM uses and DT applications. Enhanced cooperation and coordination amongst interested parties. Improved precision in design integration, scheduling, and cost prediction, which lowers mistakes and rework.

Increased safety assurance and risk management using digital simulations and real-time monitoring. Smooth transition and long-term asset management backed by CAFM systems, digital twins, and as-built models.

In conclusion, the Parnell Road apartment project's delivery is transformed into a future-ready development that exemplifies best practices in risk mitigation, cost efficiency, and sustainable facility management through the integration of BIM and DTs, offering long-term value to the client, contractors, and end users.

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