Unlock Time Savings with Integrated Digital Delivery

LUM CHANG BUILDING CONTRACTORS' IDD EXPERIENCE IN NORTH-SOUTH CORRIDOR (CONTRACT N110)

EXECUTIVE SUMMARY

The North-South Corridor (NSC) is a multi-modal transportation corridor that will enhance connectivity from the northern region to the city. The NSC is expected to be completed in phases from 2027 to 2029, and will feature surface streets that can be used for wider footpaths, cycling paths, bus priority measures, as well as more communal and green spaces.

In line with the project's Main Contractor's, **Lum Chang Building Contractors**, core belief that digitalisation is key to enhancing productivity and improving service delivery, several digital solutions were implemented for this project. (See Annex A for full list of IDD use cases)

For instance, to enhance the accuracy of rebar quantity estimation and reduce material wastage, Lum Chang employed BIM to produce Bar-Bending Schedules, departing from reliance on conventional 2D drawings. 3D and 4D BIM were also leveraged by the project team to aid in visualising and communicating site limitations and operational challenges.

Project
North-South Corridor (Contract N110)

Location
Ang Mo Kio Avenue 3 to Ang Mo Kio Avenue 9

Typology
Infrastructure

Developers
Land Transport Authority

Architect
ONG&ONG Pte Ltd

Main Contractor
Lum Chang Building Contractors Pte Ltd

Civil & Structural Consultant
KTP Consultants Pte Ltd

Mechanical, Electrical and Plumbing Consultant
AECOM Singapore Pte Ltd

Precast Deck Specialist
Kori Holdings Limited

To meet the exacting standards for secant bored pile installations, Lum Chang implemented the use of Robotic Total Station (RTS). This ensured high levels of precision and reduced the time required to complete the associated tasks.

Rebar Fabricator Specialist
BRC Asia Ltd.

Expected Year of Completion
2029 (for N110)

BIM-BASED PROCUREMENT AND FABRICATION OF REBARS

119 TONNES
projected reduction in material wastage

25%
time savings compared to conventional 2D method

3D AND 4D BIM FOR CONSTRUCTION SEQUENCING AND RISK MANAGEMENT

IMPROVED COMMUNICATION
during coordination meetings and stakeholder engagement

ENHANCED SITE SAFETY
with early identification of potential safety hazards

ROBOTIC TOTAL STATION FOR PILE INSTALLATION

ENHANCED ACCURACY
as errors arising from manual tasks are minimized

58%
time savings compared to conventional method

Motivated by its Digital Roadmap and IDD goals, Lum Chang is dedicated to advancing its digital transformation initiatives to achieve high-quality results and maintain its competitive advantage.

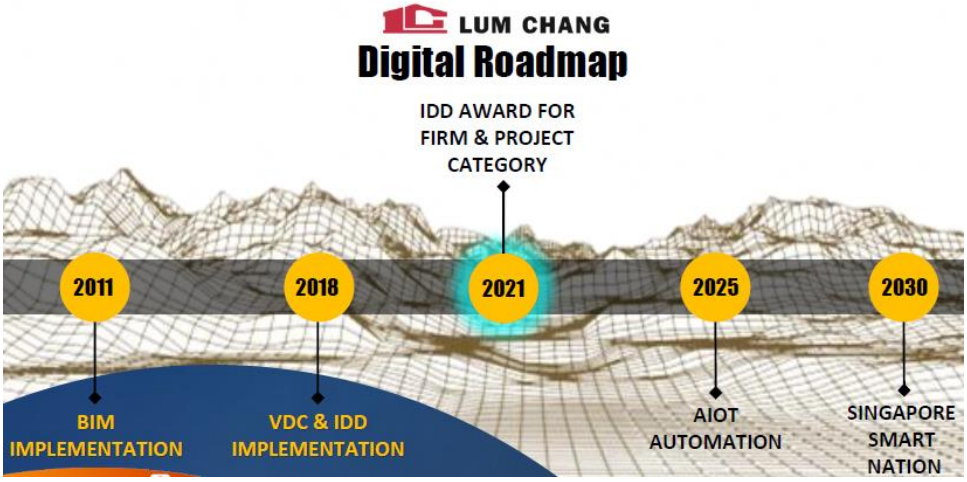
KEY MOTIVATIONS FOR IDD ADOPTION

Maintaining a Competitive Edge

Aware of the profound impact of rapid digital technology advancements in their operations, Lum Chang is steadfast in their commitment to proactively stay ahead of the curve and sustain their competitive advantage.

Their digital transformation journey began in 2011, marking them as one of Singapore's pioneering construction companies to embrace BIM 3D Modelling in projects.

Additionally, they have formulated a comprehensive Digital Roadmap delineating key milestones to be accomplished by 2030. (Refer to Annex B for Lum Chang's Digitalisation Milestones)

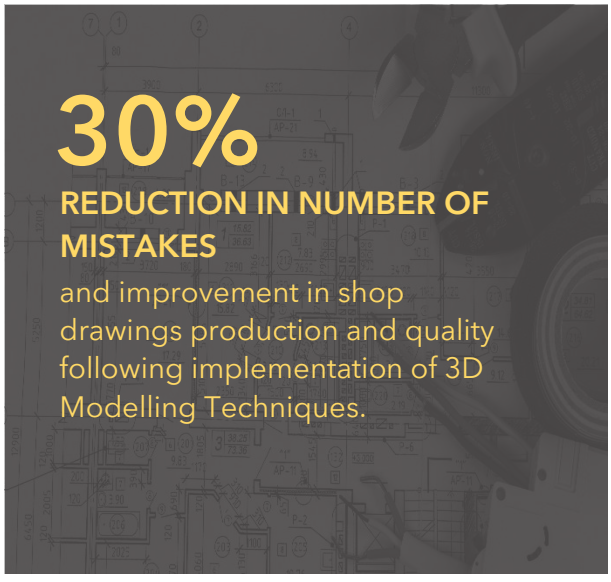


Lum Chang Digital Roadmap

Spurred by Past Success

Having started their digital transformation early, Lum Chang observed that the implementation of digital solutions in projects effectively reduced the time, errors and costs associated with construction planning process.

This reinforced their determination to integrate BIM/ IDD into their projects and align themselves with new technologies to improve their workflow processes.



Commitment to Quality-based Project Delivery

Lum Chang undertakes a range of intricate projects, including civil and infrastructure works that necessitate a high level of precision and accuracy.

Acknowledging that traditional practices could not facilitate efficient achievement of these outcomes, Lum Chang was driven to harness diverse digital technologies and processes to enhance collaboration, coordination, and communication. This endeavour has resulted in improved efficiency, reduced errors, and enhanced overall project quality.

KEY FOCUS AREAS FOR IDD IMPLEMENTATION

Having amassed experience in infrastructure projects and the use of BIM/IDD, Lum Chang was able to identify specific areas and processes for improvement, along with the

corresponding tools and solutions to achieve the desired outcomes.

The following paragraphs highlights three of these solutions that were implemented for NSC (Contract N110).

Digital Procurement

Bim-Based Procurement and Fabrication of Rebars

Lum Chang previously relied on rebar specialists to estimate the required quantities based on 2D drawings. However, inaccuracies in these estimates, stemming from design coordination issues and human errors, would often lead to material wastage, disputes and additional time spent verifying quantities. These eventually translated to additional project costs.

To tackle this challenge, Lum Chang began to leverage BIM to produce Bar-Bending Schedules (BBS), which enabled higher accuracy and efficient representation of the reinforcement requirements.

This approach facilitated consistency between the model and fabrication, and improved coordination among design, coordination and fabrication teams. Lum Chang was also able to better monitor and assess the required amount of rebars, leading to more effective cross-phase integration with their rebar specialist.

Rebar wastage projected to reduce by 119 tonnes

25% time savings (approximately 9,348 work hours)

How it was implemented

1

IMPORT

Integration of BRC's Revit template into Lum Chang's BIM model

- The template comprised datasets with details such as rebar shape codes and schedule templates, as well as plug-in.
- This integration also facilitated the subsequent transfer of information from the resulting rebar model into BRC's rebar production procedures.

2

MODEL

Preparation of rebar model and detailing in Revit

- Once integrated, Lum Chang could tap on the datasets to prepare the rebar model from the BIM model.
- Simultaneously, the integrated Revit plug-in was also able to validate and perform automated quality checks (e.g., rebar shape code, cutting & bending dimensions) on the rebar model.

3

EXPORT

Generation of Bar Bending Schedule (BBS) from rebar model and exporting to BRC

- Lum Chang then generated the Bar Bending Schedule (BBS) from the rebar model, which helped minimized potential misinterpretations of structural drawings. It also automated manual tasks such as rebar quantities and bending calculations.
- The BBS was then exported to a pre-formatted Microsoft Excel file to prepare for procurement.

4

PROCURE

Procurement based on BBS

- Upon receipt of the excel file, BRC extracted the Purchase Order (PO) information from the BBS to prepare for procurement and fabrication.
- BRC was able to streamline this process as the information within the file was already aligned with the requirements of BRC's Online Rebar Ordering System.

5

FABRICATE

Production initiated based on receipt of BBS by BRC's Bcore and ERP system

- The integration of BBS into BRC's Bcore & ERP system then triggered the fabrication and manufacturing process.
- The ERP system controls and manages BRC's Computerised Numerical Control machines (CNC) for rebar fabrication.

6

PAYMENT

Leverage BBS for progress payments

- The BIM-based BBS was also utilized to facilitate progress payments to BRC.
- Payments were tied to the completion milestones in the production, delivery and installation of rebars onsite.
- This ensured that payments were accurate and aligned with the actual number of rebars produced.

Visualisation and Design Checks

3D and 4D BIM for Construction Sequencing and Risk Management

The conventional approach to understanding construction sequences typically involves analysing 2D drawings. One significant drawback of relying on 2D drawings lies in its inability to provide a comprehensive understanding of the physical space, making it challenging to visualise and coordinate complex construction activities.

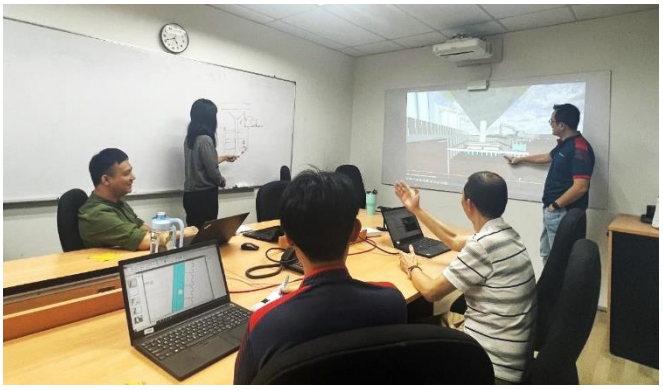
This challenge is further compounded when conveying complex work sequences to stakeholders, hindering their ability to gain a clear visualisation and understanding of the planned activities.

For a complex project like NSC N110, Lum Chang leveraged 3D and 4D BIM to illustrate and communicate the intricate sequences involved in construction works, including temporary works.

This facilitated the application of Design for Safety (DfS) principles and enabled the project team to effectively manage potential risks arising from slope stability works around the facility building and underpinning of the existing MRT pier.

Improved communication during site meetings

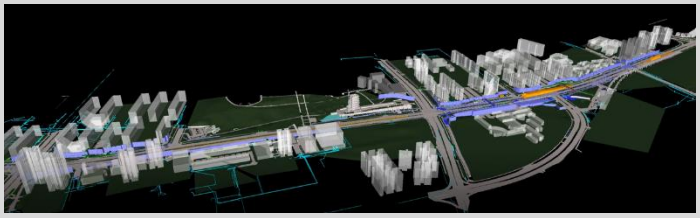
Earlier identification of potential risks and hazards



Using 4D BIM to visualize spatial layout and explore alternatives prior to execution of works

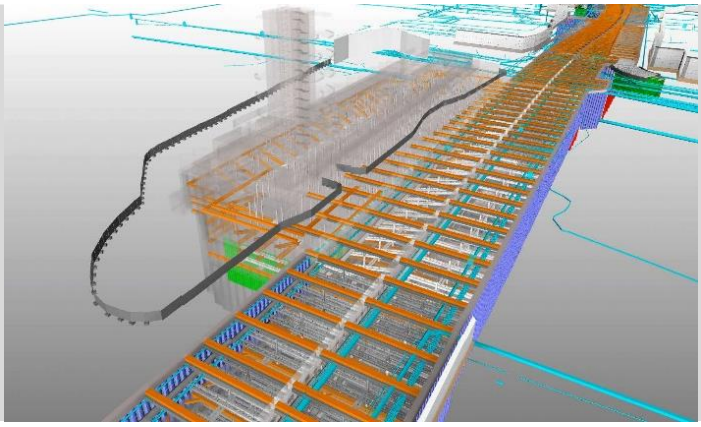
How it was implemented

1



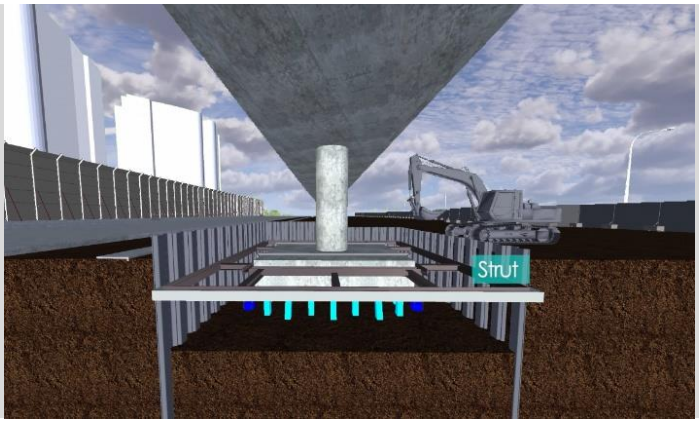
Existing site features, specifically conditions within a 150m radius from the worksite, were incorporated into the 3D BIM model.

2



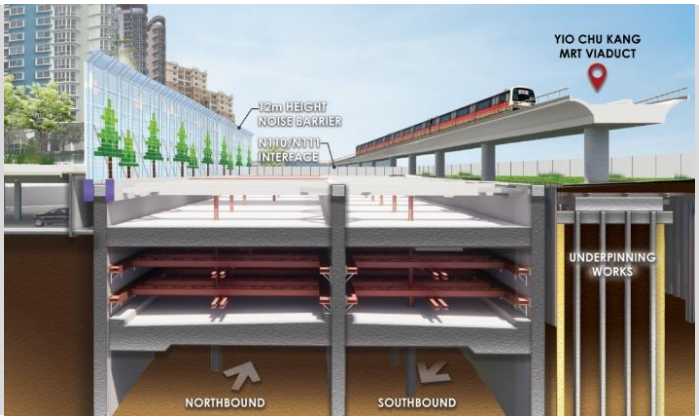
Temporary works (e.g. soil nails, secant-bored piles, underpinning), existing and new underground utilities were added subsequently.

3



Leveraging the 3D BIM model to develop 4D construction sequence videos, site constraints and operation challenges were identified and brought to project team's attention before works commenced on site.

4



Project team was able to design workarounds and optimize sequencing of tasks to minimize conflicts and improve efficiency.

Robotic Total Station for Secant Bored Pile Installations

The use of manual total stations for verifying geo-referenced coordinate points has been a longstanding practice in the surveying and construction field. While essential, the manual procedures involved in operating the equipment can lead to inaccuracies and reduced time efficiency.

Being an infrastructure project, the NSC N110 project demanded high precision and accuracy in all areas. To meet these requirements, Lum Chang adopted the use of Robotic Total Station (RTS), particularly for the installation of Secant Bored Piles (SBP).

The RTS is an advanced surveying instrument that integrates traditional total station technology with robotic automation. It offers high precision, verifying points based on BIM coordinates with a tolerance of 1mm.

Additionally, it reduces reliance on manpower compared to manual total stations, as it is equipped with automated features that eliminate the need for constant manual operation.

COMPARISON OF TIME REQUIRED FOR VERIFICATION OF ONE AS-BUILT SECANT BORED PILE

Manual Total Station		Robotic Total Station	
Workflow	**Manhours**	**Workflow**	**Manhours**
Surveyor Team Measurement of as-built SBP coordinates	8	**BIM Team** Extract approved SBP coordinates for transfer to RTS	3
Surveyor Team Key in information to CAD for cross-checking & approval	8	**Surveyor & Drafting Teams** Verify coordinates on-site and download to dxf. or xls.	6
Surveyor & Drafting Teams Drafter to update changes to 2D drawings	8	**BIM Team** Update 3D BIM model	1
TOTAL MANHOURS REQUIRED	**24**	**TOTAL MANHOURS REQUIRED**	**10**

Time savings of **14 manhours (58%)**
(compared to Manual Total Station)

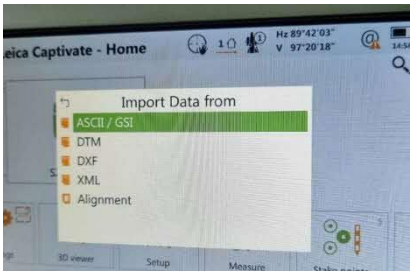
How it was implemented

1 IMPORT

- Geo-referenced coordinates of the secant bored piles modelled in BIM were imported to the RTS in an IFC file format*.

  **The IFC (Industry Foundation Classes), is an open file format specification commonly used in the Built Environment sector to facilitate interoperability between different software applications.*

- For NSC N110, the utilisation of a Leica RTS necessitated the downloading of a corresponding add-on into the BIM modelling software (Autodesk Revit).



RTS can support data imported in other formats as well.

2 PROJECTION AND VERIFICATION

- Once imported, surveyors could visualise the coordinates through the built-in 3D viewer.
- The RTS was then used to project a laser beam onto the physical element to ascertain specific coordinate points, commonly known as stake points.
- The stake points were subsequently validated for the installation for SBP.

Projection and verification of stake points

3 UPDATE

- Coordinates of SBP installation points were updated in RTS and exported back to the BIM model (in IFC file format) for corresponding updating.

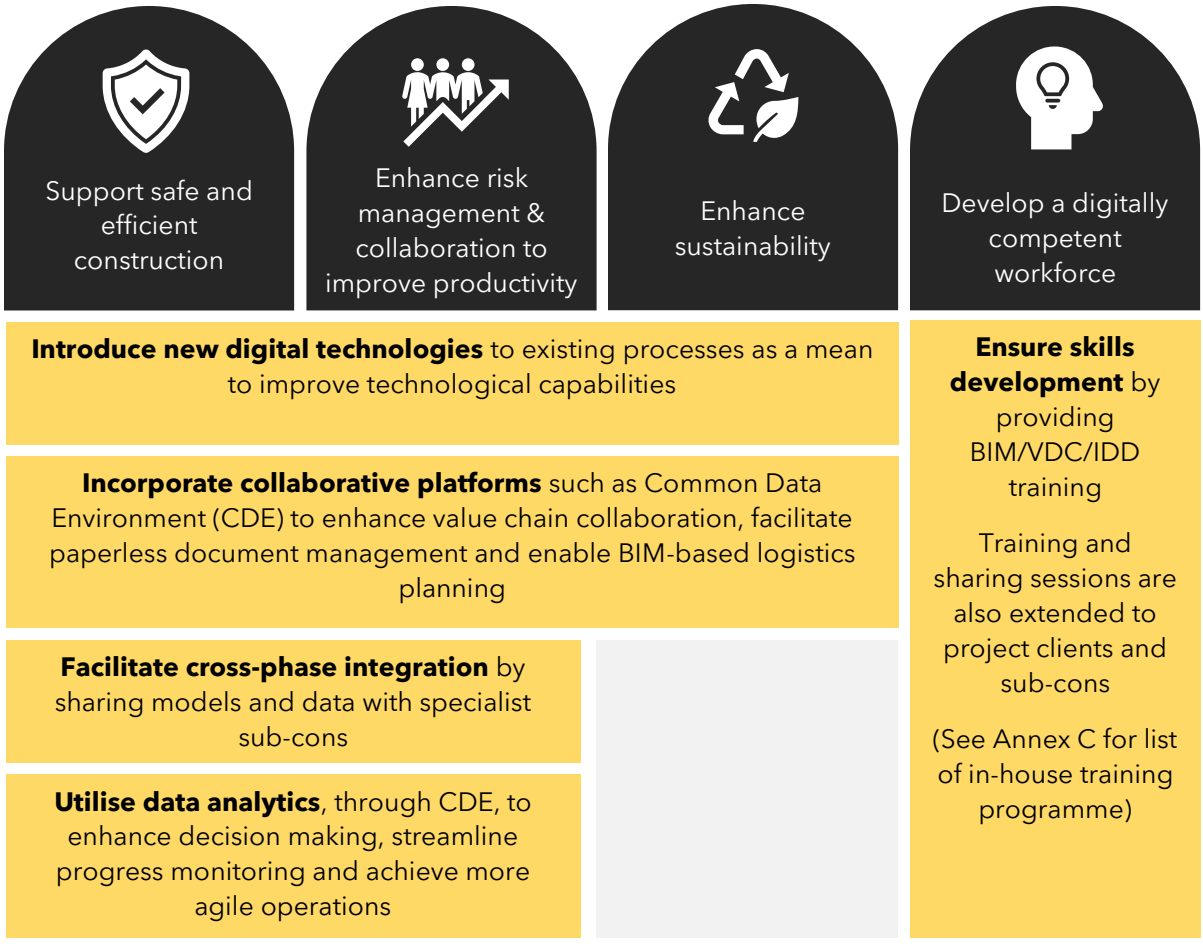
CHANGE MANAGEMENT STRATEGIES

Lum Chang was aware that for the organization to fully embrace digital transformation and be proficiently adept in BIM/IDD, change needed to be enacted across all levels of the organisation. The subsequent paragraphs outline several strategies pursued by Lum Chang to accomplish these objectives.

Analysing Business Needs and IDD Goals before Identifying To-Dos

Lum Chang recognised the importance of having a clear purpose and sense of direction before embarking on their IDD journey. The management team responsible for digital transformation carefully examined the organisation's business needs and goals relating to IDD before formulating the corresponding action plan.

Lum Chang's IDD Goals and Core Efforts



Senior Management Taking the Lead

When implementing organisational changes, it is common for employees to initially resist. At Lum Chang, where most employees were primarily accustomed to using 2D drawings in their daily work, the concept of BIM models did not immediately resonate with them.

To foster a shift in mindset, Lum Chang's management led by example by acquainting themselves with BIM first, before advocating its adoption to the rest of the organisation. Project Directors and Managers also began incorporating BIM models in meetings and site visits, encouraging their staff to adapt their work methods.

The success of these leadership initiatives and proactive measures is evident in the widespread acceptance and integration of BIM into the current workflow of Lum Chang's employees.

Equipping Staff and Project Stakeholders with BIM/IDD Skillsets

In addition to fostering a mindset shift towards BIM/IDD within the organisation, it was equally crucial to ensure that employees possessed the requisite skillsets to effectively implement BIM/IDD in projects.

In response to this need, Lum Chang instituted a Training and Competency Framework that encompasses both organisation-wide and project-specific training requirements.

The organisation-wide training consists fundamental and advanced levels, tailored to address the needs of employees at different skill levels and to focus on specific competencies. Project-specific training is customised to align with the digital technologies and solutions required for each project.

Lum Chang's Training and Competency Framework

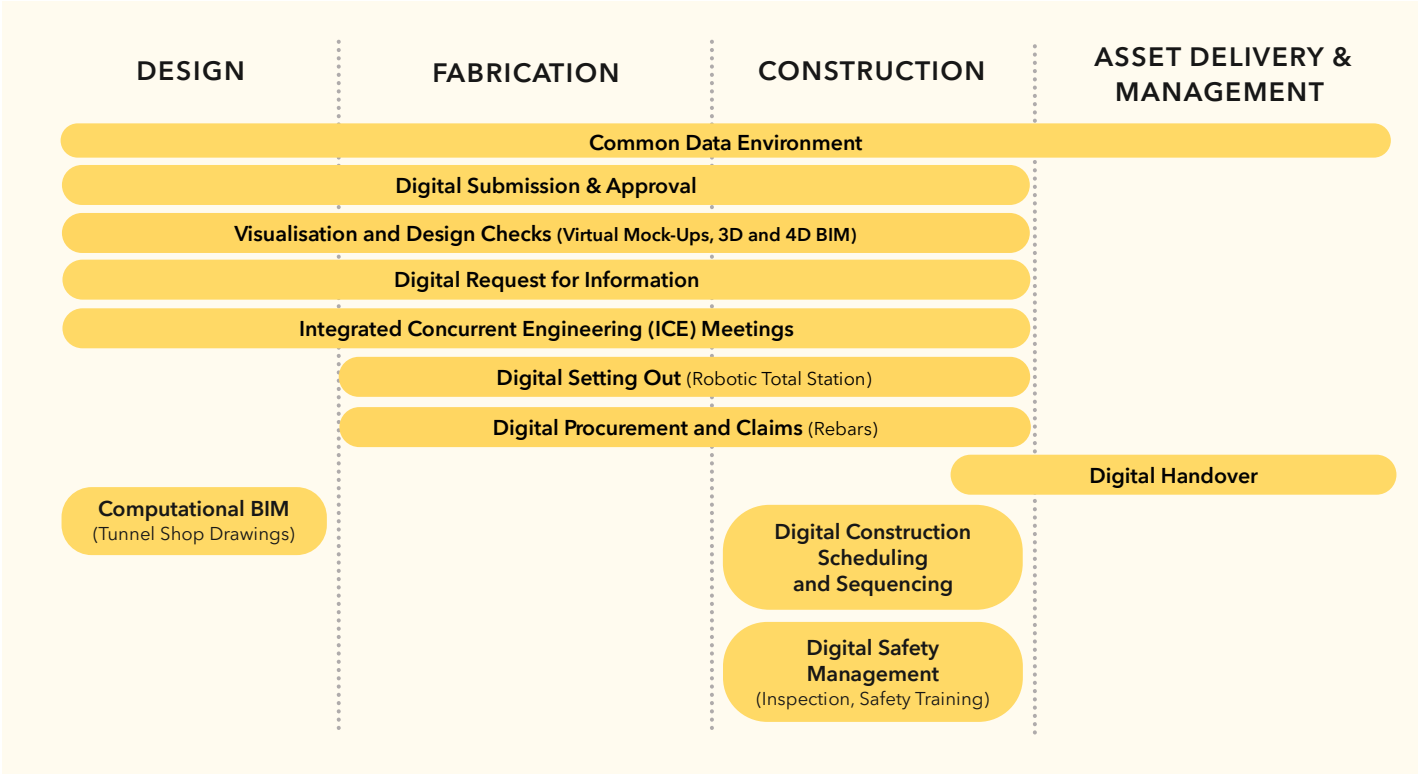
For Organisation

Training Type	Purpose	Competencies	Target Group
Fundamental	Build up fundamental knowledge of BIM	BIM Navigation	All Management and Project Development Personnel
Advanced	Build up additional skills required for coordination works	BIM Coordination, Clash Detection, BIM Authoring	BIM/ Technical Staff

For Projects

Training Type	Purpose	Competencies	Target Group
Common Data Environment (CDE)	Improve project coordination, collaboration & documentation	CDE Navigation	All project personnel
Integrated Digital Delivery (IDD)	Ensure competency in implementing IDD solutions	IDD Implementation	Relevant project personnel

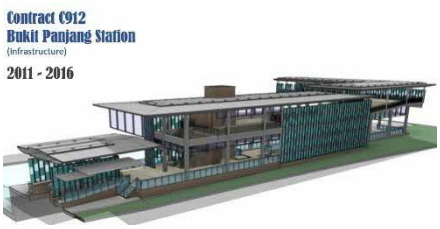
Annex A – List of IDD Use Cases for NSC (N110)



Annex B – Lum Chang's Digitalisation Milestones

2011

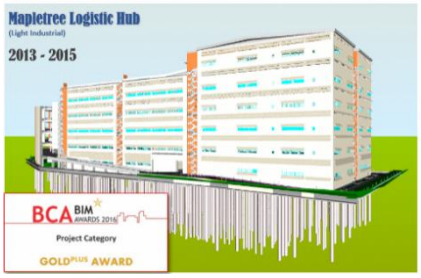
Bt Panjang Station (C912)



3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering

2013

Mapletree Logistics Hub
(BCA BIM Awards 2016)



3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering
BIM based Shop Drawing

2014

Kampung Admiralty
(BCA BIM Awards 2017)

3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering
BIM based Shop Drawing
4D BIM Simulation

2015

Northpoint City
(BCA BIM Awards 2017)

3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering
BIM based Shop Drawing
4D BIM Simulation
Facilities Management Data Input
Common Data Environment

2017

3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering
BIM based Shop Drawing
4D BIM Simulation
Common Data Environment
6D Facilities Asset Management
Computational BIM
5D Quantity Take Off
3D Laser Scanning
Digital QA/ QC

2018

PSA Livable City
(BCA Awards 2022)

3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering
BIM based Shop Drawing
4D BIM Simulation
6D Facilities Asset Management
Common Data Environment
Computational BIM
5D Quantity Take Off
3D Laser Scanning
Digital QA/ QC
Digital Mock-Up
VR-based Safety Training
Digital PTW
BIM-Based Fabrication
BIM-Based Procurement
Progress Monitoring (Drone Inspection)

2018

North South Corridor N110
(BCA Awards 2022)

3D BIM Modelling
3D BIM Coordination
Clash Detection
3D Rendering
BIM based Shop Drawing
4D BIM Simulation
6D Facilities Asset Management
Common Data Environment
Computational BIM
5D Quantity Take Off
3D Laser Scanning
Digital QA/ QC
Digital Mock-Up
VR-based Safety Training
Digital PTW
BIM-Based Fabrication
BIM-Based Procurement
Robotic Total Station

Annex C – Lum Chang's In-House Training Programme

Training Programme	Brief Syllabus	Target Group
Navigation of Tender Model and Quantity Take-Offs (3D DGN Model)	1. Setup Individual User Profile and Work Screen 2. Navigation of 3D Model 3. Quantity Take-Offs from 3D Model 4. Measurement	• Tender Technical Team *(Engineers and Architectural Coordinators)* • Tender QS Team
Navigation of Tender Model and Quantity Take-Offs (3D RVT Model)	1. Setup Individual User Profile and Work Screen 2. Navigation of 3D Model 3. Quantity Take-Offs from 3D Model 4. Measurement	• Tender Technical Team *(Engineers and Architectural Coordinators)* Tender QS Team
4D Quantity Take-Offs in CostX using 3D Models	Quantity Take-Offs using CostX *(For all the different trades)*	• All QS
5D Progress Claim in CostX using 3D models	1. Importing 3D Builder Works into CostX 2. Importing 3D M&E Works into CostX 3. Payment Claim Worksheet 4. Report Generated from CostX	• Project QS
Design Review and BIM to Field Navigation using Navisworks and DWF	1. Navigation of 3D Model 2. Sectioning of 3D Model 3. Review and Measurement	• Technical Team *(C&S and M&E Engineers and Architectural Coordinators)* • Operation Team *(Site Engineers)* • All QS

Training Programme	Brief Syllabus	Target Group
3D Modelling and Good Practices	A different set of modules will be taught each month *(i.e. 12 modules each year)* Modules are pre-determined at the beginning of the year and are subject to change on an annual basis. (For 2023: 1. Precast Staircase, Railing and Pool 2. Wall Joins/Parts/Room Colour Schedule 3. Building Regulations – BCA 4. Building Regulations – BFA 5. Building Regulations – LTA 6. Building Regulations – NEA/PUB 7. Building Regulations – SCDF 8. 2D Parametric Details/Advance Detailing 9. Navisworks Clash Detection 10. Façade Modelling 11. Steel Structure 12. Key Schedule	• BIM Team
Computational BIM	There will be two classes per year. *E.g. Use of Dynamo to automate tedious repetitive tasks such as updating the piling model to As-Built toe levels and extraction of coordinates into excel for Land Surveyor to transfer to the Robotic Total Station to verify the position in the field.*	• BIM Team
<Optional> Walkthrough Animation	1. Animating elements in Navisworks *(e.g. Swing of a door, moving the mobile crane)* 2. Scripting a movement 3. Adding the script to the element *(e.g. To pre-determine a route for a presentation walkthrough and script the doors to swing open when the avatar is within 1m of the door during the walkthrough)*	• Anyone