

# IDD Implementation Guide

## GETTING STARTED

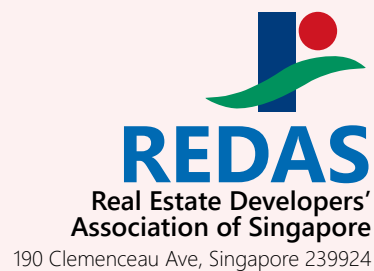


# IDD Implementation Guide

## Developers' Getting Started Guide

REDAS -Real Estate Developers' Association of Singapore

**Version 1.1**  
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NOTE

This document is owned and updated by REDAS for the Developer Centric Dashboard

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**PREFACE****What this guide is about ?**

The purpose and scope of this document “IDD Implementation Guide for Developers - *Getting Started Guide*” is to make all developers in Singapore to understand the processes and deployment of IDD (Integrated Digital Delivery) in their projects at the very basic level. As this is a “Getting Started” guide, the implementation of IDD will focus on the minimum requirements for all the project stakeholders to kickstart the process of IDD in their projects.

There will be another detailed IDD guide for developers, to ensure high quality of project delivery and to develop efficiency in their industry by implementing the full scope of IDD in their building projects. This guide will also include the recommended digital tools that are currently available in the market and will explain their proper use for the digital delivery.

**Change of mind-set**

In order to effectively implement IDD processes in a project, it is very important to understand that the traditional way of doing things may become redundant and new set of skills and knowledge need to be learnt. This entails that, initially the investment on new hardware and software and time required to retrain in certain aspects of project delivery may not sound attractive, but this will be compensated by huge gains in the long run.

Hence every organisation wanting to implement IDD must deploy a Change Management Strategy to change the mind-set of professionals in its businesses to embrace this new way of digitalizing the built-environment industry.

To help the industry and prepare its members for the IDD Deployment, there are several training courses available, some of which are listed in pages 22-23.

The legal aspects of project delivery in the form of contracts and contractual obligations on the part of consultants and contractors need to be spelt out very clearly by the developers in their EIR (Exchange Information Requirement) and AIR (Asset Information Requirement) and should be included in the conditions of projects contracts.

# 1.1

## What is IDD ? Introduction

### 1.11 IDD Defined`

The Integrated Digital Delivery (IDD) is a Singapore government initiative to promote digitalization of the built environment industry and the IDD framework has been proposed by BCA as a part of the Industry Transformation Map. Integrated Digital Delivery (IDD) leverages digital technologies to integrate work processes and project stakeholders in a unified way throughout the entire life cycle of the built asset right from inception to completion of a project (including the digital FM). This includes design, fabrication, and assembly on-site as well as operations and maintenance of the asset. IDD is one of the government's key initiatives in the Built Environment Industry Transformation Map (ITM).  
(Source : BCA)



### 1.12 IDD is for the Built Environment

Integrated Digital Delivery as defined above is for all the stakeholders of a built environment (BE) project. The IDD framework shall integrate the various processes such as design, construction, fabrication, and asset delivery within a digital platform and leveraging tools such that it addresses the productivity challenges of the BE industry. IDD offers an outcome-based approach towards project delivery and helps realize cost, time, productivity, and sustainability efficiencies for the project.

### 1.13 Industry Transformation Map (ITM)

The ITMs were launched in 2016 under the FEC as road maps to drive transformation for 23 industries across manufacturing, built environment, trade and connectivity, essential domestic services, modern services and lifestyle. The Industry Transformation Map is a partnerships between the Government, companies, trade associations and chambers, and the Labour Movement. Each Industry Transformation Map (ITM) lays out the blueprint and key strategies needed to drive the industry forward.

To seize new opportunities in a post-Covid-19 world, Singapore's 23 Industry Transformation Maps (ITMs) will be refreshed as part of a new plan over the next five years.(ITM-2025). To better address the needs of businesses and Singaporeans, and translate R&D into business solutions and products, the FEC's (Future Economy Council) work has been reorganised to align with the four RIE(Research, Innovation and Enterprise) domains: manufacturing, trade and connectivity; human health and potential; urban solutions and sustainability; and smart nation and digital economy. The new ITM has been launched and can be accessed at <https://www1.bca.gov.sg/buildsg/built-environment-industry-transformation-map>

(Source : from str.sg)

# 1.2

## What is IDD ? Definition of IDD

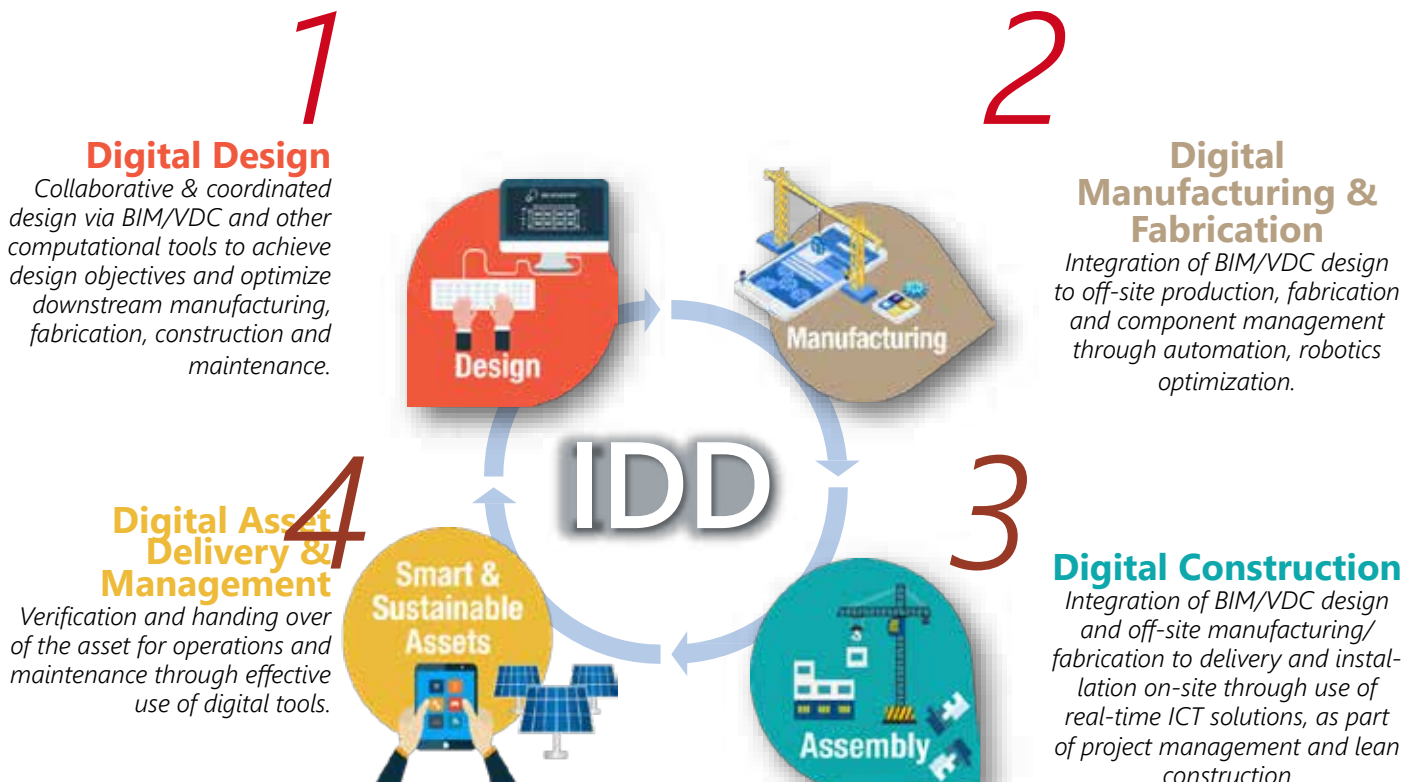
### 1.21 SCOPE OF IDD

Area	Purpose
Digital Design	Achieve design objectives through effective collaboration and coordination to meet client's, regulatory and downstream requirements
Digital Fabrication	Integration of BIM/VDC design to off-site production, fabrication and component management through automation, robotics optimization.
Digital Construction	Integration of BIM/VDC design and off-site manufacturing/fabrication to delivery and installation on-site through use of real-time ICT solutions, as part of project management and Lean construction
Digital Asset Management	Verification and handing over of the asset for operations and maintenance through effective use of digital tools

### 1.22 Key Thrusts of ITM

KEY THRUST	DESCRIPTION
DFMA	<ul style="list-style-type: none"> <li>- Design upfront for ease of manufacturing and assembly</li> <li>- Highly automated offsite production facilities</li> <li>- Efficient and clean on-site installation process</li> </ul>
GREEN BUILDINGS	<ul style="list-style-type: none"> <li>- Design for Green Buildings</li> <li>- Sustainable practices in operations and maintenance</li> </ul>
<b>IDD</b>	- Enabled by Building Information Modelling (BIM), IDD fully integrates processes and stakeholders along the value chain through advanced info-communications technology (ICT) and smart technologies

### 1.23 The four pillars of IDD



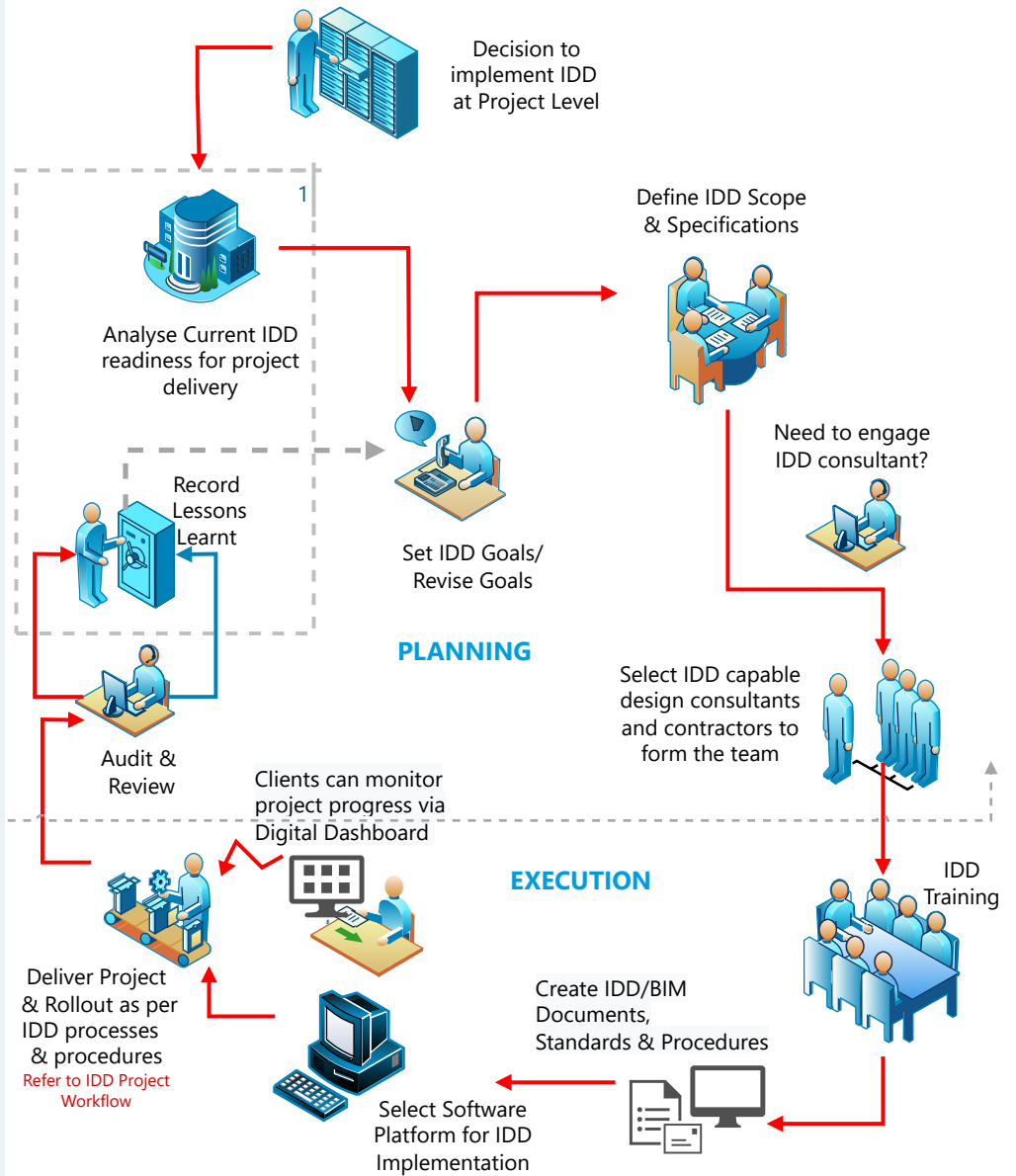
# 1.3

## What is IDD ? IDD Implementation Workflow

### IDD Implementation Workflow

The workflow described here in an ideal situation for project delivery recommends the following :

- Decision to deploy IDD shall be made by the developer, & as such should be specified in the tender document.
- All the stakeholders of the projects such as Consultants, Contractors, Fabricators or Facility Managers shall be either IDD ready or make necessary arrangement to equip themselves with IDD expertise
- The workflow shown here is to facilitate all the project stake holders to equip themselves with the necessary resources and price them accordingly for the project delivery
- The developers can equip themselves with the IDD knowledge, technology tools and Implementation process by attending necessary training courses as listed in pages 22-23
- Ideally each project shall have a BIM Manager who can double up as the IDD Manager for the purpose of implementing IDD processes
- For large projects it may be necessary to have a separate IDD consultant who shall report to the developer and shall be responsible for the IDD performance of that project
- Finally the developer shall budget for any additional cost that may be necessary for the purpose of IDD deployment and digitalization of processes including that of Digital Dashboard



# 1.4

## What is IDD ? IDD - Purpose & Benefits

### Quick Start Guide for IDD

BCA's Industry leaders quick start guide and download the same at the url:  
[https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/integrated-digital-delivery-\(idd\)/industry\\_leaders\\_quick\\_start\\_guide\\_idd.pdf](https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/integrated-digital-delivery-(idd)/industry_leaders_quick_start_guide_idd.pdf)

### 1.41 Purpose of IDD

The sole purpose of Integrated Digital Delivery (IDD) is to integrate all the processes and stakeholders of a project so that communication, collaboration and coordination amongst all the stake holders are effective. This requires many digital technologies to integrate work processes and connect project teams working on the same project to connect throughout design, fabrication, construction of a building or simply put, through the entire building life-cycle.

IDD builds on the use of Building Information Modelling (BIM) and Virtual Design and Construction (VDC), which have been implemented in many projects over the past few years.

### 1.42 Benefits of IDD

Integrated Digital Delivery (IDD) simplifies the different stages of a construction project with the integration of digital technologies that improve collaboration among stakeholders and construction efficiency, minimizes construction mistakes and costly rework, and delivers smarter buildings

#### Value for Stakeholders and the Project itself.

IDD - Value to Stakeholders				
CLIENT	DESIGNER	FABRICATOR	CONTRACTOR	ASSET/ FM OPERATOR
Best design outcome for project	Faster and better design options	Faster shop drawing approval	Reduced risk	Cost effective
Improved cost, time, and quality project goals	Better design coordination and reduced RFIs	Automated translation of design to production/ fabrication	Reduced reworks	Operations
More accurate & reliable digital asset information	Improved competitiveness	Improved production management	Higher accuracy in bidding	Enhanced life cycle management
Enhanced value of assets			More time for value engineering	Real time access to O&M manuals
			Improved safety	Streamlined maintenance regime

Source : BCA

#### Common Benefits to project Stakeholders and the Project itself.

IDD - Benefits to Project				
TIME (Developers)	COST (Consultants)	PROFIT (Developers)	SAFETY (Contractor)	QUALITY (FM)
Meet or shorten target construction period	Reduce Construction Cost/ Waste	Maximize saleable area or floor efficiency	Improve site safety	Better turnaround of quality
Reduce floor cycle time	Maximize Target cost		Reduce number of incidents	Inspections for Asset Management
Reduce Extension of Time	Reduce Contingencies		Zero fatal accidents	

Source : BCA

# 1.5

## What is IDD ? IDD - Advantages & Challenges

### 1.51 IDD Implementation - Advantages

IDD encompasses a wide range of Use Cases across the Value Chain as shown in the table below. The advantages of IDD implementation are:

- Streamlining work processes and connecting stakeholders in a project
- Standardising digital data of the project through innovation and technology
- Connecting various processes across the whole project life cycle from design, construction, fabrication, to facilities management, and
- IDD when implemented correctly can deliver a better outcome for end users.

### 1.52 IDD Implementation - Challenges

As IDD covers a wide spectrum of processes across the entire value chain of a project delivery, it becomes a challenge to implement due to the following reasons :

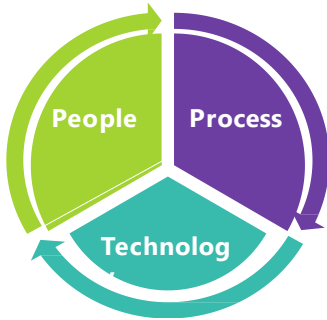
- Management support & buy-in to implement IDD process at each stakeholder level
- Lack of trained manpower who are equipped to implement IDD as shown in table
- Additional resources and requirements such as digital tools like hardware and software
- Lack of communication, collaboration &/or coordination amongst project stakeholders, and
- Lack of Standardisation for project data including storage, sharing and data exchange

DIGITAL DESIGN	DIGITAL FABRICATION	DIGITAL CONSTRUCTION	DIGITAL ASSET MANAGEMENT
<ul style="list-style-type: none"><li>▪ Design BIM model is often not developed to tender stage</li><li>▪ Regulatory agencies are still building BIM processing capabilities</li></ul>	<ul style="list-style-type: none"><li>▪ Design and construction BIM not directly linked to manufacturing, fabrication and logistics planning and execution</li><li>▪ Opportunities for further automation, use of robotics and 3D printing</li></ul>	<ul style="list-style-type: none"><li>▪ BIM is not fully utilized during construction beyond 3D</li><li>▪ Documentation still very paper-based</li><li>▪ Real-time information not captured and used effectively to guide coordination, execution, and validation</li></ul>	<ul style="list-style-type: none"><li>▪ Building owners still learning how to link BIM to FM</li><li>▪ Lack of capability and infrastructure to support FM operations digitally.</li></ul>

Source : BCA

# 1.6

## IDD Implementation IDD Digital Dashboard

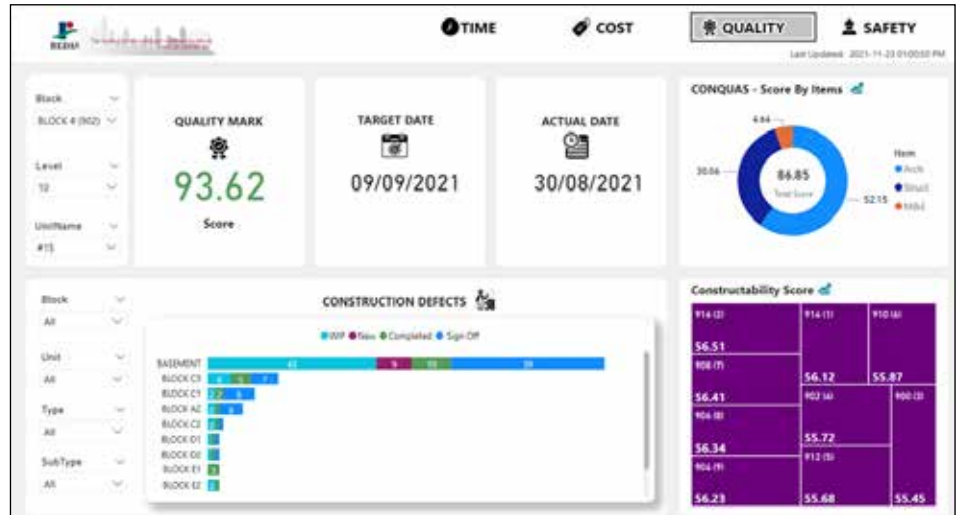


*IDD Integrates people, process and technology in a seamless way for effective project delivery.*

### 1.61 Developer Centric Digital Dashboard

The REDAS is developing a developer-centric dashboard to monitor Project KPIs. The project data such as Cost, Safety, Progress & Quality can be extracted from the IDD platforms chosen by the developers & other stakeholders of the project to be displayed onto the digital dashboard.

This digital dashboard not only allows monitoring of project health but data collected can be used for benchmarking purpose to help upgrade the built environment industry in Singapore to a higher level. A sample page of the dashboard is shown below :



Some of the KPIs being monitored for the Developer Centric Digital Dashboard :

Source : REDAS

<b>COST</b> Project Profitability- & ROI	1. Number of VOs 2. Cashflow Management (Cost) 3. Actual vs Budget Cost Estimation 4. Defect Management (cost) 5. Operating Cost	Digital Progress Monitoring
		Digital Construction Scheduling and Sequencing
		Construction Time and Cost
		Design Time and Cost
		Procurement Handling and Management
		Digital Defects Management
		Digital Handover
		Digital Operations and Maintenance
		Real-time Monitoring of Assets Performance
<b>SAFETY</b> Performance	1. Workplace Inquires 2. Safety Violations	No of Accidents – Major
		No of Accidents – Minor
		No of Accidents – Fatal
		No of Near Miss Cases
<b>TIME</b> Progress Time, Predictability	1. Digital Request for Information (RFI) 2. Compliance and Approval 3. Defect Management (time delay)	Digital Progress Monitoring
		Construction Scheduling/Sequencing
		Digital Submission & Approval
		Digital QA/QC Inspections
		Digital Defects Management
<b>QUALITY</b> Quality Assurance	1. Defects Management	Digital Handover
		Digital QA/QC inspections
		Digital Defects Management
		Digital Handover
		Visualization and Design Checks
		CONQUAS Score Monitoring
T&C of M&E Equipment		

2.02

# IDD Implementation

**Project considerations for implementing IDD**

Before deciding on implementing IDD in your project, you will have to ask the following questions and understand your current gaps and shortfalls. Without closing these gaps, you will face a lot of challenges when you start implementing IDD.

*1. What are the IDD requirements from the client? Is IDD driven by the client or should be mandated in the tender requirement?*

*If the client is driving IDD implementation, then you will have no choice but to consider implementing IDD (as per EIR document). Else choose only those processes which are easy to implement first.*

*2. Do you have necessary knowledge and skills sets to implement IDD in your project? Are the project team members trained in IDD? Do they have the requisite knowledge to deliver IDD processes? If not you must first understand the value of IDD and its processes before implementing through relevant training.*

*3. Do you have the required Hardware/ Software/ licenses necessary to implement IDD processes in your project? You will need to consider powerful PCs/ Laptops to run BIM/IDD applications like Revit, Navisworks, Solibri, etc.. and budget for them as a part of project cost.*

*4. Do you know how to prepare a IDD Execution plan? (Similar to BEP) You will need to prepare IDD execution plan responding to the client's EIR. All the stakeholders must have this document before they start doing the documentation including IDD/ BIM Standards for project delivery.*

**2.11 IDD Execution Plan**

IDD Execution Plan needs to be prepared by the Lead Consultant, to provide a framework for all the stakeholders involved in the project, including architect/s, engineer/s, owner/s & design/construction managers, Contractors/Sub-contractors, Fabricators, etc.

Integrated Digital Delivery processes including Building Information Modelling (BIM) processes & various other digital technologies associated with IDD employed to deliver project towards its desired goals, quality, client expectations, time lines & agreed project budget. This IDDEP (IDD Execution Plan) document is a live document, which means that it can be revised as many times as required during the design, construction, execution and handover stages of the project. This document also captures the KPIs from the developer, the various processes & technologies and delineates roles and responsibilities of each stakeholder of the project as per their project roles.

**2.12 Best Industry Practice**

Before deciding on implementing IDD, it is worthwhile to look into Standards and governance policies in the built environment industry. It is also necessary to adhere to any code of practices, standards or project delivery guides by the building authorities. The upcoming CorenetX may specify both the model content and the way in which information is to be captured for authority submission purpose

In general it is a good practice to use a single source of truth as mentioned :

1. Designers/Architects model for submission should be used for tender and the contractors should enhance the same model by including construction specific information to the Design intent model. Hence ideally there must be only one model, which will be the single source of truth. But unfortunately after many years of delivering BIM, the industry is still struggling to overcome that.
2. There needs to have a ramp up in M&E consultants input during the digital design stage. Currently, much of the input comes from subcontractors (who come on much later part of the project). So when the M&E subcontractors feedback otherwise, the efforts of earlier coordination are mostly wasted.

### Abbreviations

OIR Organisation Information Requirement
EIR Exchange Information Requirement
AR/VR/ Augmented, Virtual Reality
AIR Asset Information Requirement
BEP BIM Execution Plan
VDC Virtual Design & Construction
CDE Common Data Environment

### 2.21 Project Deliverable

There can be several deliverable during an entire life cycle of a project. A list of some of the important deliverables are listed in the table below. The deliverables are from many stakeholders of the project including the Developers, Consultants, Contractors, Fabricators and the Asset Managers.

	Developers/ Owners/ Clients	Consultants/ Sub Consultants	Contractors/ Subcontractors	Fabricators/ Specialists	Facility Managers
<b>SCOPE OF IDD</b>	<b>Initiate IDD</b> Specify Deliverables, BIM Platform	IDD Scope : Digital Design Computational BIM, Generative Design, Data Analytics (AI/ML)	IDD Scope : Digital Constructions tools	IDD Scope : Digital Fabrication	IDD Scope : Digital Asset Management
<b>DOCUMENTS EXPECTED</b>	EIR, AIR, OIR, CDE, Design Brief BIM Standards (ISO-19650)	BEP, IDDEP, DIM(Design Information Model) Cost Plan/ Estimation, BIM Standards (ISO-19650)	BIM Execution Plan PIM (Proj Information Model) BIM Standards (ISO-19650)	BIM Execution Plan Interoperability Standards, BIM Standards	AIR AIM (Asset Information Model) BIM Standards
<b>PROCESSES EXPECTED</b>	CDE, VDC AR/VR/MR	Common Data Environment, Integrated Concurrent Engineering, Virtual Design & Construction, AR/VR/MR, Visualisation	Common Data Environment, Integrated Concurrent Engineering, Virtual Design & Construction, AR/VR/MR, Visualisation	Common Data Environment BIM2Machine	Common Data Environment AR/VR/MR
<b>TECHNOLOGY PLATFORM</b>	PM - Novade Cost Management Project Progress	CDE - BIM 360 Projectwise Aconex	CDE - BIM 360 Projectwise/ Aconex Issue Management platforms like Novade	CDE - BIM 360 Projectwise Aconex	Mobile FM PM- Assets Management
<b>SOFTWARE TOOLS</b>	BIM VIEWERS	Revit, Autocad, Navisworks, Archicad, Bentley aecosim Rhino, grasshopper, dynamo, python	Revit, autocad, Navisworks Archicad, Bentley aecosim Novade	Revit, autocad Navisworks, Archicad, Bentley aecosim	Several vendor specific tools Omni from SJ
<b>DATA FORMATS</b>	IFC, RVT, DWG, PLN	IFC, RVT, DWG, PLN, NWD,	IFC, RVT, DWG, PLN, NWD	IFC, RVT, DWG, PLN	IFC, RVT, DWG, PLN

### IDD Implementation - Process, Procedures, Technologies : Some Use Cases

DESIGN	FABRICATION	CONSTRUCTION	FACILITY MANAGEMENT
ISO-19650 Standards	Fabrication Coordination	CDE - Cloud based Collaboration	Lidar As-Build Verification
Generative Design	BIM based Fabrication Docs	ICE Coordination-Construction	Defects Management
Computational BIM	Quantity Takeoff	Digital Virtual Mock Up	Digital Commissioning
Design Optimization	ShopDwg Submission- Approval	RFIs & Issue Tracking	Smart Operations
Design Analysis	Digital Procurement	Material Submission/ Approvals	IOT sensor Monitoring
Design Simulations	Production Planning	ShopDwg Submission- Approval	Real Time Asset Performance
CDE -Integrated Design Model	Scheduling for JIT delivery	Construction Planning, Scheduling	Monitoring
ICE Coordination	Off Site Production Automation	Cost Planning & Management	
Digital Virtual Mock Up	Production Tracking/ Monitoring	BIM to field - Survey	
Animations & Visualisation	QA/QC Inspection	Drone - Progress Monitoring	
QA/QC - Model Checking	Logistics Tracking/ Monitoring	Drone - Defect Management	
QA/QC - Code Checking		Construction Robotics	
Cost Planning / Estimation		Safety Planning/ Surveillance	
Tender Docs and Specifications			

3.03

# First Steps

# 3.1

## First Steps Collaborative Workflow

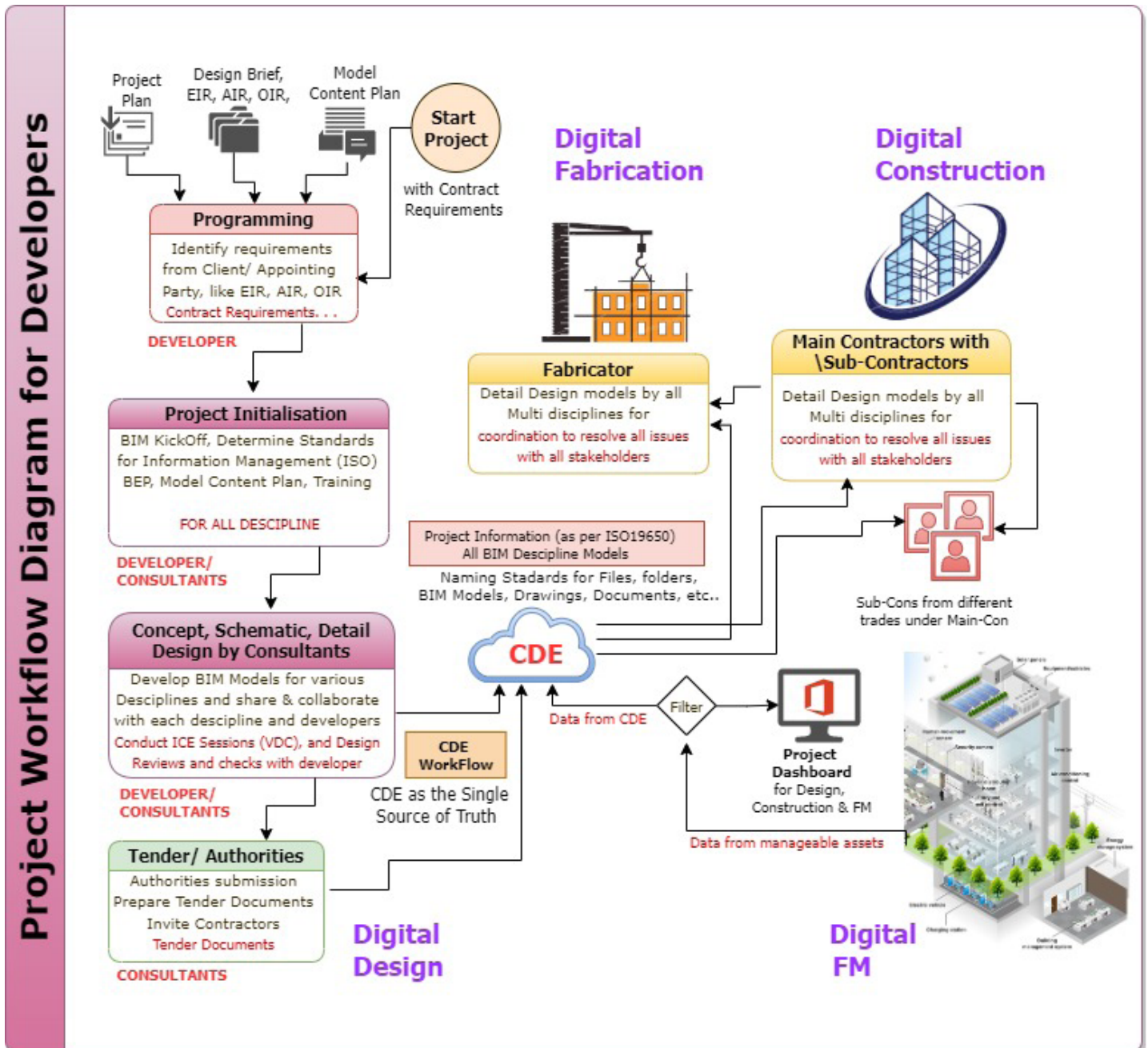
### 3.31. IDD-Collaboration is the key

One of the greatest benefits of BIM collaboration is the opportunity to construct a project in a virtual world before construction begins on site. This will minimize the chance for costly errors and reworks on site thereby minimizing overall project cost and delivery time. A lot of information is produced as part of a project. The information produced could be in digital or paper format. This information is often unstructured, poorly coordinated and difficult to locate when

needed most. The resultant inefficiencies is estimated to cost all the stakeholders of the project. As IDD stands for Integration, which is essentially the collaboration and coordination across many project processes & stakeholders, it becomes necessary to bring all parties under one roof called the “common data environment”, which is also called as a “single source of truth”. In essence, VDC is to “Build Twice” - first Virtually, and then Physically. Building twice enables a project team to fully simulate design and construction in a virtual

first prior to actual execution on site. This framework requires all stakeholders to commit to working collaboratively towards achieving a common set of goals, through systematically modelling what is to be built, rehearsing what is to be built, and building what was modelled and rehearsed, and through constantly measuring and narrowing deviations between what was built (real) and what was modelled and rehearsed (virtual). In the BCA guidelines for VDC these strategies have been spelt out.

IDD - Integrated Digital Delivery Workflow



### 3.20 ISO 19650 Series

ISO-19650 standards have been published and is available at [www.iso.org](http://www.iso.org)

ISO 19650 part 1:	This part outlines the concepts and principles and provides recommendations on how to manage building information.
ISO 19650 part 2:	This part supplies information management requirements in the delivery phase of assets.
ISO 19650 part 3:	This part supplies information management requirements for the operational phase of the assets.
ISO 19650 part 5:	This international standard sets out requirements for the security-minded management of sensitive information within building information modelling (BIM).

### 3.23 Definition of CDE

CDE is the repository & the “single source of truth” used for collecting, managing and disseminating documentation, including the graphical model and non-graphical data for the whole project team (i.e. all project information whether created in a BIM environment or in a conventional data format). Creating this single source of information facilitates collaboration between project team members and helps avoid duplication and mistakes. As per BCA’s definition, CDE is a common digital space that hosts the relevant information for collaboration, exchange and communication to deliver a project.

### 3.21 What is ISO-19650 Standards

The ISO 19650 standard is an international standard for managing information over the whole life cycle of a built asset (building) using building information modelling (BIM). ISO 19650 comes in several parts specifying information management at different stages of the project including management processes during the delivery and operational phase of the built assets.

### 3.22 Why we need ISO 19650

The benefits of BIM are not just limited to Design and Construction phases but also extend throughout the project life cycle, from operation to decommissioning phases. It is therefore very important for all the parties to understand its concepts to ensure proper implementation of BIM in the project. In order to bring in consistency across all the parties and to achieve the returns on their investment in the BIM process, a form of standardization for managing information is necessary. ISO 19650 fulfils this need for information management using BIM

As a part of project delivery using ISO-19650, following documentation and processes are mandatory:

- EIR / PIR	- Exchange Information Requirements (EIR), Project Information Requirements (PIR) captures BIM objectives, Level of information and needs (LOIN), Roles and Responsibilities, collaboration process, coordination & clash detection, classification of information as per existing standards.
- AIR	- Asset Information Requirements (AIR), define the information required to operate and maintain a built asset in line with an organization’s asset management strategy..
- BEP	- BIM Execution Plan (BEP), documents how the project will be delivered using BIM, including Project Coordinates, naming conventions, Level of information, standards for data management
- PIM/ AIM	- Project Information Model / Asset Information Model are BIM deliverables (models) prepared at the appropriate stages of the project as per the details defined in the BEP
- CDE	- A Central repository for storing project data which ensures consistent and better managed project information and process for project data at all stages of the project from inception to completion
- VDC	- Virtual design and construction (VDC), is a process of coordinating the multi-disciplinary BIM models at design &/or construction stage of a project in order to support explicit and business objectives of the stakeholders.

### 3.24 CDE Components:

CDE comprises two components – the Data Standard and the Data Platform. The Common Data Environment (CDE) aims to:

- Ensure consistent and better managed project information and process;
- Allow project team members timely access to up-to-date, relevant and reliable project information in a common and structured environment for delivery;
- Facilitate close collaboration among project team members through sharing, exchanging, communicating and managing the project information in a common space;
- Enable project teams to derive useful project performance insights for trending purpose;
- Ownership of information remains with the originator, although it is shared and reused, only the originator shall change it;
- Shared information reduces the time and cost in producing coordinated information;
- Any number of documents can be generated from different combinations of model files.;
- Work in progress (WIP): area is used to hold unapproved information for each organisation;
- Shared (or client shared) area - this information has been checked, reviewed and approved for sharing with other organizations, perhaps including the client;
- Published - this information has been authorized or accepted by the client or their representatives (often the lead supplier (designer/contractor)); and
- Archived - this area is used to create a constant record of progress throughout the life cycle as well as all transaction and change orders.

# 3.3

## First Steps Adoption of Common Use cases

Some of the common uses cases for IDD are listed in the table below which can be implemented easily to start with. These use cases have readily available software tools and can be implemented with minimum difficulty. For a list of available tools & software please refer to chapter 3.5 - Software Solutions & Tools.

IDD ACTIVITY	DIGITAL USE CASE	DEFINITION	DIGITAL DELIVERABLES	BENEFITS
Coordination	<b>1. Digital RFI- Request for Information</b>	Seek clarification using digital platform to track, resolve and communicate the issues raised	Issues and resolution dashboard, Digital notes of discussion & Updated BIM models	Fewer & Leaner RFI, Track on Changes and Audit Trail Reduce Risk of Cost Overrun
	<b>2. Integrated concurrent Engineering (ICE) meetings</b>	Conduct technical, review, coordination meetings with therelevant project team in a collaborative way & enabled by digital technologies/ BIM	Digital records of decisions (e.g. federated models), Actions to be taken and Parties responsible	Design Team Productivity Gain Document Meeting Minutes for Resolution and Audit Trial
	<b>3. Visualization and design checks</b>	Utilize digital 3D models/ immersive technologies like AR/VR/MR) to seek feedback a& validate design aspects, space requirements & other settings	Digital 3D models (can be further processed according to project needs) Rendered models	Improve Quality and reduce rework due to non coordination
Design Review	<b>4. Digital submission &amp; approval</b>	Submit deliverables for various stakeholders through digital means	Information required for tracking; decision records	Reduce risk & rework due to missing/ wrong data
Tender	<b>5. BIM-based tender documentation</b>	Prepare tender documents based on information primarily generatedfrom BIM models	BIM models, Drawings Tender specifications	Improved Efficiency and Accuracy in Quantification Process Approval workflow
Cost Estimation	<b>6. BIM Based Cost Estimation</b>	Estimate Costs at various project stages based on available information from BIM models	Costing models Costing and quantity-take-off documentation	Manage Bottom line Understand changes quickly
Logistics Planning & Management	<b>7. Digital logistics</b>	Plan prefabrication production schedule, and track and monitorthe production, delivery and installation of the prefab components digitally	Production schedule; Digital logistic delivery records	Planning for success and construction acceleration
Construction Planning & Scheduling	<b>8. Digital construction scheduling</b>	Plan and monitor construction activities using digital constructionscheduling, simulation and sequencing	4D time-based construction schedules, simulations or sequencing models	Construction Project Schedule acceleration and visibility on project progress
Progress Monitoring	<b>9. Digital progress monitoring</b>	Monitor site progress using digitalsolutions/scanning and update schedules and 3D models for progress reports and payments	Records of site progress photos, updates to schedules & 3D models and Progress Reports (actual vs planned; current month vs previous month)	Construction Field Management Productivity Gains
Site Installation/ Construction	<b>10. Digital QA/QC inspections</b>	Record observations and track follow-ups using digital solutions	Records of QA/QC site inspections; Audit trails of resolution/approvals	Field Management Productivity Gains; Improved Quality, and Margins, & Reduce Rework & Cost Overruns
Defects Management	<b>11. Digital defects management (Optional)</b>	Manage and track defects and rectification using digital checklistsand dashboards	Master defects list; Digital defects location record; Defects rectification reports	Improved Margins, and Reduce Rework and quicker handover
Facility Management	<b>12. Digital Handover</b>	The process of Main-Contractor handing over the built asset to owner	List of all rectified defects; Any deviations in as-built asset	Improvement in quality of project delivery
	<b>13. Real-time monitoring of assets performance</b>	Using digital tools and technologies such as IOT sensors or other BMS sensors to monitor the performance of manageable assets	Real-time Dashboard with asset parameters being displayed in Real time	To give a high level of service to customers and end users in terms of the health of the building. (building services)
Building Operations	<b>14. Digital Operations and Maintenance</b>	Using digital tools such as mobile and handheld devices to perform building services and attend maintenance calls	Service request calls and service rendered reports delivered on mobile devices	Better quality of services and fast turn around in building maintenance

# 3.4

## First Steps Quick Start Template

The following quick start template will help the developer to explore the project goals, methodologies and deliverables at each stage of the project from Design, Fabrication. Construction and Asset Management. The developer has to create his EIR and AIR which will specify how his requirements specific to the project are to be met..

DIGITAL DESIGN		
Goal Description	Methodology & Action by the Developer	Deliverables
<b>DESIGN REVIEW</b> Design Sign-off within 5 months of appointment. Improvement in the time spent for design validation & verification (heights/level/rooms layout confirmation) Significant reduction in design change	Design Validation and Verification using rule based checking software like Solibri for headroom, access control. Checking & populating attribute data and information into the BIM Model as per AIR <b>Action: Developer to participate in the design reviews with his BIM Manager/ BIM Team</b>	BIM Models to agreed with LOD (such as LOD 350 for construction) Clash free BIM Models validated against local building codes and regulations, Data Rich BIM Models as specified in BEP document.
<b>3D COORDINATION</b> Utilising Immersive technology VR Collab / VR Coordination	Visualising federated models in VR environment such as HTC Vive or Cave .VRS system <b>Action: Developer to participate in VDC &amp; ICE Sessions</b>	Visualisation Format suitable for VR Collab software as specified in BEP
<b>VDC COORDINATION</b> BIM utilised for design and client engagement before construction & installation	Using VDC processes and ICE and PPM sessions to resolve all design and construction issues <b>Action: Developer to participate in VDC &amp; ICE Sessions</b>	Clash Free Federated BIM models using appropriate coordination tools as specified in BEP
<b>DRONE TECH</b> Drones will be used for Site study and Analysis	Using Photogrammetry for slope analysis & optimal design & construction logistics <b>Action: Developer to review drone footage &amp; site analysis</b>	Drone Photography and videos for site analysis at the concept design stage as specified in BEP
<b>COMPUTATIONAL DESIGN</b> Design Optimization & for Value Engineering	Dynamo script to optimise design on Revit Models for concrete elements such as columns, slabs, beams	Scripts or codes specific project for optimizing the design as specified in BEP
<b>QUANTIFICATION</b> BIM Attributes are required for quantification purposes as per QBAR Standards	QBAR Standards for the Unit of Measurement Elemental Schedule at different LODs such as 200,300 & 350	Schedule of quantities for the Project as specified in BEP

DIGITAL FABRICATION		
Goal Description	Methodology & Action by the Developer	Deliverables
<b>DfMA</b> Design optimization & off-Site production of structural and MEP parts structural framing and facade in metal screens PPVC and PBUs wherever possible	Standardise and unitize building elements BIM to Machine using CNC and Robotics; Standardise bath room layouts, explore PPVC & PBU possibilities, explore MEP DfMA Modules <b>Action: Developer to specify the extent and scope for the DfMA in the project as per his project goals &amp; objectives</b>	DfMA Modules, MEP skids structural steel elements and facade elements, PPVC/ PBU Modules
<b>SCHEDULING &amp; PRODUCTION</b> Schedule & update all DfMA elements in advance for factory fabrication	Just in time production as per schedule and construction program <b>Action: Developer to monitor the schedule using digital tools including dashboards</b>	BIM schedules & construction programs
<b>SAFETY</b> Safety simulations of construction process to avoid accidents	Use appropriate simulation software to study safety issues and troubleshoot any probable situations <b>Action: Developer to monitor site safety closely</b>	Simulations using BIM models for construction activities like lifting, transporting heavy equipments to heights (either basement or roof)
<b>ERROR FREE FABRICATION</b> All pre-fabricated elements are checked before delivery	Use VDC and Clash detection methods to remove any design or construction issues	Clash Free or BIM Models with all critical clashes resolved for all the disciplines including architectural, structural and MEP
<b>LOGISTICS &amp; SITE DELIVERY</b> JIT (just-in-time) delivery to reduce storage requirements at site	4D simulations to monitor Actual vs Planned progress and use QR Code for logistics	Digitalize logistics work-flow, 4D animations

# First Steps Quick Start Template

DIGITAL CONSTRUCTION		
Goal Description	Methodology & Action by the Developer	Deliverables
<b>CONSTRUCTION SCHEDULES</b> Plan and monitor construction activities using digital construction scheduling, simulation and sequencing	4D BIM simulations to visualise the construction sequence to be prepared by main-contractor <b>Action: Developer to visualise the 4D BIM Simulation and approve the sequence of works to be carried out</b>	4D Simulation to agreed detail to be delivered using Navisworks or similar software tools
<b>DIGITAL PROGRESS MONITORING</b> Schedule & update all DfMA elements in advance for factory fabrication	Construction Program from the Main Contractor to be prepared before the construction starts <b>Action: Developer to monitor the progress of the project on a regular basis by comparing actual progress vs planned sequence</b>	Construction Programs and Schedules in the form of Gantt Chart and construction program using Primavera or MS Project
<b>SITE SAFETY</b> Safety simulations of construction process to avoid accidents and incidents at site	Use simulation software like Navis works to study Safety issues. Record site safety incidents and accidents and report on a regular basis <b>Action: Developer to monitor site safety issues and take corrective actions to minimise incidents &amp; accidents at site</b>	Safety reports on regular basis. Site safety training for workers and other construction professionals
<b>DIGITAL QA/QC</b> Record observations and track follow-ups using digital solutions for construction quality. Manage and track defects and rectification using digital checklists and dashboards	Records of QA/QC site inspections; Audit trails of resolution/approvals using digital solutions like Novade, etc.. <b>Action: Developer to monitor construction QA/QC from the main and sub-cons.</b>	QA/QC reports and monthly construction progress reports  Dashboards for updating QA/QC checks and defects management

DIGITAL ASSET MANAGEMENT		
Goal Description	Methodology & Action by the Developer	Deliverables
As-Built Model as per EIR/ AIR	BIM model in agreed authoring software	LOD 500 BIM Model
COBie Data Drops	COBie spreadsheet capturing all the design and construction data for the purpose of Facility Management	Excel Spread Sheet with list of manageable assets and its' attribute data
QA/QC and Final Inspection before Client take-over	Comparison using point cloud data with the design intent model to verify the accuracy and correctness of construction	Comparison Report using appropriate tools for superimposing pointcloud over BIM models

Plan/ Design	Fabri- cate	Construct	Operate
Project Planning Stage - Design Brief - Site Analysis - Conceptual Design			
	Design Authoring & Analysis - Define BIM Software/Tools - Define BIM Team Structure - Define LOD; Deliverables - Design Model Configuration		
		Collaboration & Coordination - 3D/4D Collaboration - Construction Model Configuration - Clash Detection; Verification - Fabrication; Automation - Facility Management via COBie	
			Construction & HandOver As built Model COBie-Design Validation/ FM

## NOTE :

IDD is INTEGRATION of processes, stakeholders in a project  
 IDD processes span across the entire LIFE-CYCLE of a project  
 IDD is BCA's initiative to DIGITALIZE BE industry in Singapore  
 IDD is set of defined PROCESSES & not hardware or software  
 IDD can be PROGRESSIVELY implemented in your company  
 IDD includes many of the ISO 19650 standards like CDE, etc..  
 IDD requires proper planning before deployment in a project  
 IDD training can be obtained in Singapore from various IHLs



4.04

# IDD Training

# 4.1

## IDD Training IDD Courses offered in Singapore



REDAS SJ SURBANA JURONG SINGAPORE BUSINESS FEDERATION SBF RISE PROGRAMME

**IDD**  
Integrated Digital Delivery for the Built Environment

**REDAS-SJ IDD Training Series:**  
Integrated Digital Delivery (IDD) Implementation for your project

**Course Overview**  
Design and construction of built-assets is a complex time driven process, which requires close coordination between

**EVENT DETAILS**  
Date: 5 March 2021 (Friday)

### 4.11 REDAS Courses for Developers

Several courses have been planned by REDAS to upgrade all developers staff to understand and then implement IDD in their project. These courses will be announced in REDAS' projects website and developers are encouraged to check the available dates

Currently some courses are offered by both REDAS and BCA for the general public in the built environment industry. Details on schedules and course fees etc.. can be obtained from their respective web sites. These are :

### 4.12 IDD Implementation for your projects by REDAS

– To deliver smart buildings, it is imperative to say that collaboration and integration of digital technologies across this wide spectrum becomes the key driving force. IDD tries to bridge this collaborative approach by a series of integrated digital technologies. In this course you learn about the concepts of IDD processes and how to implement them in your projects with the help of use cases

### 4.13 Principles of IDD - BCA

– To better support the industry to reap the full benefits of IDD, this course is designed to equip BE professionals with good understanding and aligned knowledge on IDD across the built environment value chain. Learners will be systematically guided through a series of topics on the concept and methods to effectively adopt IDD in their projects or organizations, curated in bite-sized and interactive formats.



**BCA ACADEMY**

**PRINCIPLES OF INTEGRATED DIGITAL DELIVERY**

**E-LEARNING**  
100% online. May include pre-recorded session, live streaming/webinar and discussion forum, where applicable.

**ONLINE LEARNING:**  
Date: 21 Feb 2022\*  
Platform: BCAA Learning

Building on the momentum of BIM Roadmaps, BCA introduced Integrated Digital Delivery (IDD) to better connect built environment stakeholders and streamline their work processes, through innovative use of digital technologies.

To support the industry to reap the full benefits of IDD, this course is designed to equip BE professionals with good understanding and aligned knowledge on IDD across the built environment value chain. Learners will be systematically guided through a series of topics on the concept and method to effectively adopt IDD in their projects or organizations, curated in bite-sized and interactive format.

**OBJECTIVES**

- To level up learners' understanding on the concept of IDD across the built environment value chain.

### 4.14 IDD Project Implementation - BCA

– As an extension of the fundamental course on "Principles of Integrated Digital Delivery" and to better support BE firms or project teams to adopt IDD confidently, this programme has been curated to guide participants through the process of adopting a proper IDD structure to their projects or organisations



**E-LEARNING**  
100% online. May include pre-recorded session, live streaming/webinar and discussion forum, where applicable.

**BCA ACADEMY**

**IDD PROJECT IMPLEMENTATION**

**2<sup>nd</sup> RUN**  
Date: 29 Oct. 5 & 19 Nov. 3 & 17

Building on the momentum of BIM Roadmaps, BCA introduced Integrated Digital Delivery (IDD) to enlarge the digitalization of the entire built environment (BE) value chain through innovative use of



### 4.21 REDAS-SJ IDD Appreciation Course

#### Course Overview

Design and construction of built-assets is a complex time driven process, which requires close coordination between the owner, consultant, contractors, project manager and other building specialists. To deliver smart buildings, it is imperative to say that collaboration and integration of digital technologies across this wide spectrum becomes the key driving force. IDD tries to bridge this collaborative approach by a series of integrated digital technologies. To deploy IDD in the built environment, it is important for all the stakeholders of the project to understand the goals / objectives and the underlying principles and technologies of IDD such as Building Information Modelling (BIM), Virtual Design & Construction (VDC), Augmented Reality & Virtual Reality (AR/VR), Computational Design, Digital Assets Management, and international standards for project delivery and information management such as ISO 19650. There is bright scope for IDD in the future, which

might encompass using computers and digital technologies such as AI and Machine Learning for Building Design and Automation, Robotics & IOT for construction and maintenance of buildings.

CPD: Qualified for 3 PDUs by PEB, Pending for SPM and SISV

#### Learning Outcomes :

At the end of this course, participants should be able to:

- Have a clear understanding on the scope of IDD processes;
- Understand and appreciate various processes of IDD;
- Appreciate various tools and technologies involved in implementing IDD.

#### Who Should Attend :

- Building Owners, Developers,
- Project Managers, Architects, MEP Engineers,
- Quantity Surveyors, FM Service Providers,
- Main Contractors, Sub Contractors, etc..

#### Course Structure

- IDD Scope & Content
- Digital Design
- Digital Fabrication
- Digital Construction
- Digital Asset Management

### 4.31 Digital Delivery Management Accreditation Scheme

(Source : busildingSMART) SkillsFuture initiative (<https://www.skillsfuture.gov.sg/>) developed for the Singapore workforce is to promote skills mastery & lifelong learning, is also an integral component of the Construction Industry Transformation Map. (ITM). Jointly developed by SkillsFuture Singapore (SSG), Workforce Singapore (WSG) and Building and Construction Authority (BCA), together with industry associations, training providers, organisations and unions, the Skills Framework for Built Environment provides useful information on career pathways, occupations, job roles, skills & competencies and training programmes.

buildingSMART, Singapore (bSS) is the Accreditation Body for the Digital Delivery Management (DDM) track of the Built Environment Skills Framework. The Skills Framework allows professionals within this track to structure their career for progression. As the Accreditation Body, bSS recognizes the candidate's skills, knowledge and experience gained to help him/her rise through the ranks in his/her profession with a standing based on the 4 different levels. Currently, bSS provides a scheme to accredit the Specialist (Tier 3) and Lead (2) positions followed by Assistant Specialist (Tier 4) and Chief Digital Officer (Tier 1) by mid of 2022.

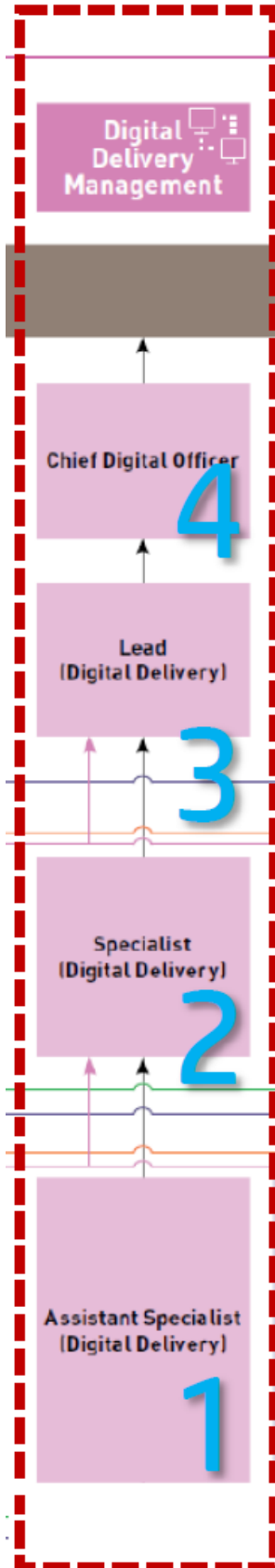
To learn more on accreditation scheme visit

<https://ddm.buildingsmartsingapore.org/ddm-accreditation-overview/>

The following table illustrates the job roles and career pathways within the Built Environment. The DDM Accreditation Scheme provides candidates with a structured pathway to progress along the DDM pathway (as denoted in pink). Source : ddm-accreditation portal

<p><b>Tier 1:</b> The Chief Digital Officer oversees the overall implementation and innovation of digital solutions in the organisation to achieve digital transformation of the business. They drive the team to experiment and apply new digital solutions. They lead the strategic direction for their team to ensure efficiency in projects and operations. They drive collaboration within the organisation and endorse the work done by the digital team.</p>	<p><b>Tier 3:</b> The Specialist (Digital Delivery) is involved in project delivery, digital solutions development and adoption and competency building. They interpret business requirements and help to translate them into digital solutions. They are familiar with digital solutions and business requirements to add value to the business. They provide timely and value-added services to end-user digital solutions. They ensure that the quality of information and models prepared by the specialists adhere to the prescribed standards and protocol for sharing and coordination purposes. They are also involved in training. They are independent and possess strong problem-solving skills. They keep abreast with new digital technologies and are keen to experiment and adopt new digital solutions to enhance project outcomes. They work in a fast-paced environment that is highly collaborative with multiple stakeholders.</p>
<p><b>Tier 2:</b> The Lead (Digital Delivery) plays leading roles in project delivery, digital solutions development and adoption, competency building and innovation. They oversee the development and acquisition of digital solutions. They implement policies and processes to support the organisation's strategies. They are responsible for analysing how digital solutions can be used to optimise processes. They are involved in technology adoption, innovation and associated change management activities. They establish guidelines for the implementation of new solutions and continuous process improvement to drive capability building. They possess expertise in digital technologies, are adept in adopting digital solutions to enhance project outcomes and resolve technical challenges. They provide technical guidance and support to their team and are keen to ensure they keep abreast with the latest in digital delivery approaches. They work in a fast-paced environment and manage multiple projects and stakeholders.</p>	<p><b>Tier 4:</b> The Assistant Specialist (Digital Delivery) assists in project delivery, development and adoption of digital solutions and competency building. They participate in product and model development, planning, research and/or testing of digital solutions and training. They gather data and information to understand business needs and user requirements to support adoption and implementation of digital and/or automated building solutions and resolve issues. They are a team player and possess strong communication skills to interact with relevant stakeholders and subject matter experts. They are also resourceful and able to collate information required to develop digital solutions. They work in a fast-paced environment and may be required to work both on- and off-site.</p>

## DDM



### 4.32 DDM Modes of Assessment

There are a total of 3 modes of assessment to ascertain your competency for the desired tier. These are: the Logbook, Assessment Test, and Case Study (only on Appeal). This section provides more information on each mode of assessment.

#### Logbook

The logbook will be used to assess the applicant's key tasks and responsibilities and project experience. The project write-up(s), peer reviews and supervisor's assessment will also add further verification on the applicant's critical core skills such as communication and digital literacy. The logbook should list the candidate's work experience in BIM and IDD projects. There is a validity period of 5 years for projects handled or completed by the applicant to be considered towards accreditation. Each project should have the minimum GFA of not less than 5000sqm to be considered. The contact details of the candidate's supervisor and HR Manager shall be listed in the document as the Assessment Committee for the DDM Accreditation Scheme may seek clarification from the supervisor or peers listed in the logbook to request further information or support documentation to verify the competencies of the applicant. The peer could be the applicant's supervisor or project team members who had worked on the same project as the applicant and should be of equivalent or higher standing than the applicant (e.g. Project Director). The logbook must show that the candidate is able to meet 75% of Key Tasks stated in the Skills Map. For Lead accreditation, the candidate is required to produce a BIM or IDD Execution Plan that they have authored as part of the documentation submitted.

→ Requirements	→ Specialist (Tier 3)	→ Lead (Tier 2)
→ Working Experience in BE sector (with qualification)	→ 2 years (Degree holders) 3 years (Diploma/NITEC)	→ 4 years (Degree holders) 5 years (Diploma/NITEC)
→ Working Experience in BE sector (without qualification)	→ 4* years	→ 6* years
→ * Min. 2 years in local context		
→ Projects handled/completed in the last 5 years	→ 3 BIM/IDD Projects	→ 5 BIM/IDD Projects (at least 1 IDD Project)
→ Peer Recommendations	→ 3 Reviews	→ 3 Reviews
→ Evidence of Competency	→ 75% of Relevant Key Tasks 3 out of 5 Critical Core Skills	→ 75% of Relevant Key Tasks 3 out of 5 Critical Core Skills

Without qualification refers to someone whose academic background is not from the Built Environment. An administrator will call up the references listed in the logbook for verification.

#### Assessment Test

The Assessment Test is a compulsory aspect of the Accreditation Framework. It verifies that the candidate meets the Technical Skills and Competencies as listed on the Skills Map.

→ Requirements	→ Specialist (Tier 3)	→ Lead (Tier 2)
→ Evidence of Competency	→ 8 Core + 6 Elective Technical Skills and Competencies	→ 8 Core + 10 Elective Technical Skills and Competencies

Questions for the Assessment Test are not software or platform specific as the industry uses different tools for different purposes. The test will focus on the methodologies and applications, rather than skill set or competence in the use of a particular software or tool. The Question Bank is created and validated by a team of industry professionals and representatives from Institutes of Higher Learning. The questions will be primarily based on the Core TSC Modules identified as crucial for a DDM professional to function at the workplace. A short section of the assessment will be based on TSCs which the candidate may elect based on their background.

5.05

# Appendix

# 5.1

## Appendix Abbreviations

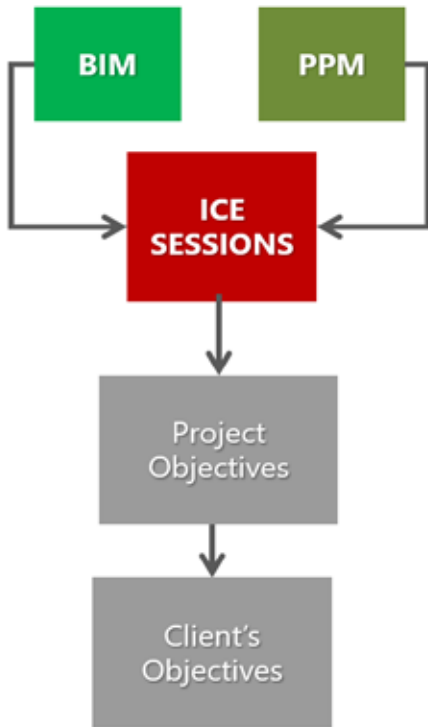
Abbr	Expansion of Abbreviation
AC	Accredited Checker
BCA	Building and Construction Authority
BOA	Board of Architects
DPAP	Development Projects Advisory Panel
DPC	Department of Public Cleanliness
DSTA	Defence Science Technology Agency
FSE	Fire Safety Engineering and Specialist
FSSD	Fire Safety and Shelter Department
IMDA	Info-communications Media Development Authority
LTA	Land Transport Authority
NEA	National Environment Agency
NParks	National Parks Board
PM	Project Management
PEB	Professional Engineers Board
CIP	Commercially Important Person
CSC	Certificate of Statutory Completion
CV	Curriculum Vitae
CWW	Completion of Whole of Works
DC	Development Control
DCQ	Design Clarification Query
DEC	December
DfS	Design for Safety
DLP	Defects Liability Period
ECI	Early Contractor Involvement
EDMS	Electronic Document Management System
EIMS	Electronic Inspection Reporting System
EIR	Exchange Information Requirements
EMI	Electromagnetic Interference
EMS	Energy Management System
EPPM	Enterprise Project Portfolio Management
EPS	Electronic Parking Systems
ERSS	Earth Retaining or Stabilising Structures
ESC	Engineered Smoke Control

Abbr	Expansion of Abbreviation
F&B	Food & Beverage
FAT	Factory Acceptance Tests
FEED	Fire Engineering Design Brief
FER	Fire Engineering Report
FSC	Fire Safety Certificate
GFA	Gross Floor Area
GOS	Gate Operating System
GSE	Government-Sponsored Enterprise
GST	Goods and Services Tax
HT	High Tension
HVAC	Heating, Ventilation and Air-conditioning
IBMS	Intelligent Building Management Systems
ICT	Information and Communications Technology
ID	Interior Design
IFC	Issue for Construction
IFT	Issue for Tender
INC	Included
IT	Information Technology
IT Comm	Information Technology / Communications
ITT	Inter Terminal Tunnels
IVRS	Immersive Virtual Reality System
LAN	Local Area Network
LP	Lead Person
LT	Low Tension
LUX	Unit of Illuminance
M&E	Mechanical & Electrical
MATV	Master Antenna Television
MEP	Mechanical, Electrical and Plumbing
MIS	Main Intake Substations
MRT	Mass Rapid Transit
NIL	None/Nothing
NTP	Notice to Proceed
O&M	Operation & Maintenance
OT	Operational Technologies

Abbrev	Expansion of Abbreviation
PABX	Private Automatic Branch Exchange
PDC	Protective Design Centre
POS	Point of Sales
PPE	Personal Protect Equipment
Pre-Q	Pre-Qualification
PRM	Programme Risk Management
PSP	Preliminary Security Plan
QA	Quality Assurance
QC	Quality Control
RA	Risk Assessment
RAM	Reliability, Availability and Maintainability
RFI	Request for Information
RMS	Resource Management System
SDF	Skill Development Fund
SISV	Singapore Institute of Surveyors & Valuers
SPM	Society of Project Managers
T&C	Testing & Commissioning
TBM	Tunnel Boring Machine
TFP	Temporary Fire Permit
TIS	Traffic Impact Studies
TOP	Temporary Occupational Permit
UFC	Unified Facilities Criteria
UPS	Uninterruptible Power Supply
VE	Value Engineering
VGDS	Visual Guidance Docking System
VIP	Very Important Person
WAN	Wide Area Network
WSH	Workplace Safety and Health
AIR	Asset Information Requirements
OIR	Organisational Information Requirements

# 5.2

## Appendix Virtual Design & Construction (VDC)



### VDC Guide by BCA

VDC guide offers a collaborative approach to project delivery using BIM and other processes :

- Provides a common framework for VDC implementation in the Singapore context
- Consolidates best practices from both local & overseas implementation

You can download the VDC guide by BCA at [https://www.corenet.gov.sg/media/2094675/Singapore-VDC-guide\\_version1\\_oct2017.pdf](https://www.corenet.gov.sg/media/2094675/Singapore-VDC-guide_version1_oct2017.pdf)

### 5.21 IDD = BIM+VDC+ .. .. (other processes)

In order to implementing IDD in any project we need to have a minimum of two processes – BIM & IDD. We will see here what these processes are:

### 5.22 What is VDC ?

Virtual Design and Construction (VDC) is an integrated approach that combines Building Information Modelling (BIM) and advanced management methods to improve productivity. VDC will benefit both consultants and contractors to achieve productivity gains in upstream and downstream of both design and construction phases. It consists of methodologies such as Integrated Concurrent Engineering (ICE) and Process and Production Management (PPM). VDC also caters to the management of BIM models as well as people and processes in order to achieve explicit project or organisational goals and to improve performance. In essence, VDC is to “Build Twice”, first Virtually in your computer, and then Physically at Construction Site. Building twice enables a project team to fully simulate design and construction in a virtual environment first, prior to actual execution on site.

### 5.23 VDC Methodology

VDC (Virtual Design and Construction) methodology is used in the AEC industry as a combination of techniques and tools, including ICE meetings, BIM (Building Information Modelling), and PPM. The main goal of VDC methodology is to improve project quality by identifying the client’s goals supported by project objectives. To measure the efficiency of the latter, metrics such as production metrics and controllable factors are used and represent an essential part of VDC methods. VDC method was created and conceptualized in 2001, in the early days of BIM, by CIFE – Center for Integrated Facility Engineering at Stanford University of California, Professor Martin Fischer, the director of CIFE, is the forerunner of this methodology. VDC has been used in a variety of countries around the world for over 15 years. With each new project, the process has been tested and improved over time.

**BIM :** BIM is an important part of the VDC methodology. Most importantly, BIM helps with decision-making processes. Design issues can be easily communicated to the project team or the customer, through for example the BCF format and the use of BIM collaboration tools.

**PPM :** PPM (Production Management) “seeks to optimise cost, time and scope with the levers of process design, capacity, inventory and variability.” PPM is operations science applied to projects via the lens of a temporary production system.

**Metrics :** A team can gain control over a project’s objectives and how to achieve them through measurements, making Metrics a vital part of VDC. Measuring should be done on a daily or weekly basis to ensure accurate results evaluation.

Federated Models with Architecture, Structure & MEP models are used in VDC



# 5.3

## Appendix IDD Case Study: JTC's CleanTech-2



### 5.31 JTC's CleanTech Two building Source : BCA

JTC's CleanTech Two Block B building (CT2B) located within Singapore's advanced manufacturing hub, Jurong Innovation District, is one of the twelve demonstration projects identified by the Building and Construction Authority (BCA) for its exemplary implementation of Integrated Digital Delivery (IDD).

The IDD Implementation Plan, BCA's plan for the construction industry, encourages more built environment sector firms to go digital. The plan seeks to digitally integrate the entire built environment value chain to deliver better, smarter outcomes. At each stage of a construction project, ICT technologies, solutions and platforms such as Virtual Design and Construction (VDC) and Building Information Modelling (BIM) are used in IDD to streamline processes and improve collaboration between the different project teams and stakeholders. The benefits of IDD include improving construction efficiency, minimizing construction mistakes and costly rework, and the delivery of smarter buildings.



With a total gross floor area of 22,300 sqm, JTC's five-storey CT2B building hosts state-of-the-art green features such as day lighting and a fully naturally ventilated carpark. Catering to rising industry demand, CT2B provides workshop-like spaces for heavy research and prototyping activities for manufacturing technologies. The building also includes laboratory and office spaces as well as fitted labs for incubators.

Item	Quantity	Manufactured	In-Transit	Installed	Rework
Beams - Precast	233 / 233	100%	100%	100%	0%
Ext. Wall - Precast	111 / 232	48%	1%	0%	0%
Planks - Precast	585 / 585	100%	100%	100%	0%
Stairs - Precast	39 / 39	100%	0%	0%	0%

The delivery of CT2B demonstrates IDD's benefits. Its contractor, BHCC Construction Pte Ltd (BHCC), implemented a 'four-stage digitalization approach' through the project's stages of: design, fabrication, construction and asset delivery and management. The project achieved significant time and cost savings through employing digital technologies and digitizing formerly manual and time-consuming processes such as:

- Interactive Design Review using BIM Model and Virtual Reality
- Digital construction clash detection and dimension accuracy check
- Single source of truth with common data environment
- Detailed construction activity planning and tracking via digital lean management tool
- Model-based cost comparison / site model cost verification
- Fabricated building components monitoring with centralised system to reflect updated status of fabrication, logistics and installation on-site
- Drone-based site conditions and construction progress monitoring
- ore immersive Safety Induction Course with 3D simulation video

During the design stage, BHCC achieved 30% time-savings by implementing a Virtual Reality (VR) collaboration system. The system allowed project members to collaborate and coordinate designs by merging BIM data into a single model to review, analyse and simulate processes. Potential clashes were detected well in advance and addressed before construction began to maximise productivity and minimise rework.

During the construction stage, BHCC achieved 25% time-savings by using a project management platform, which enabled all project members to update on the progress of the project, including the status tracking of precast components. A further 25% time-savings will be achieved by BHCC digitalizing its management of site safety records.

By adopting a through-the-line IDD approach, the CT2B project reaped numerous benefits to the project teams and stakeholders in terms of time and cost savings, safety and quality.

## 5.41 REDAS Developers' Centric Digital Dashboard

Real Estate Developers Association of Singapore (REDAS) conceptualized a unifying platform based on the Integrated Digital Delivery (“IDD”) practice defined by Building Construction Authority (“BCA”) that allows a developer-centric approach towards managing the entire IDD life cycle. A survey was carried out by KPMG, appointed by REDAS for inviting organizations that are currently implementing BIM projects & are either using IDD approach or are attempting to adopt this approach. The list of participants was mainly from REDAS’ & BCA’s database. A survey was conducted to analyse the gaps in the industry.

The survey and subsequent interaction with the developers and their value chain partners has given REDAS a good understanding of the challenges faced by the industry. REDAS will use the findings as an internal framework to

guide the development of the Developer Centric Dashboard. These will include:

■ a. Work with the selected partner to identify specific challenges faced and propose effective solutions for the development of the APIs and Dashboard and to conduct roundtable discussions with the 8 pilot sites to further crystallize the relevant common workflow and data requirements. While the survey and interviews had suggested a list of critical reports needed, it would be necessary to ascertain more accurately the actual needs from the 8 pilots.

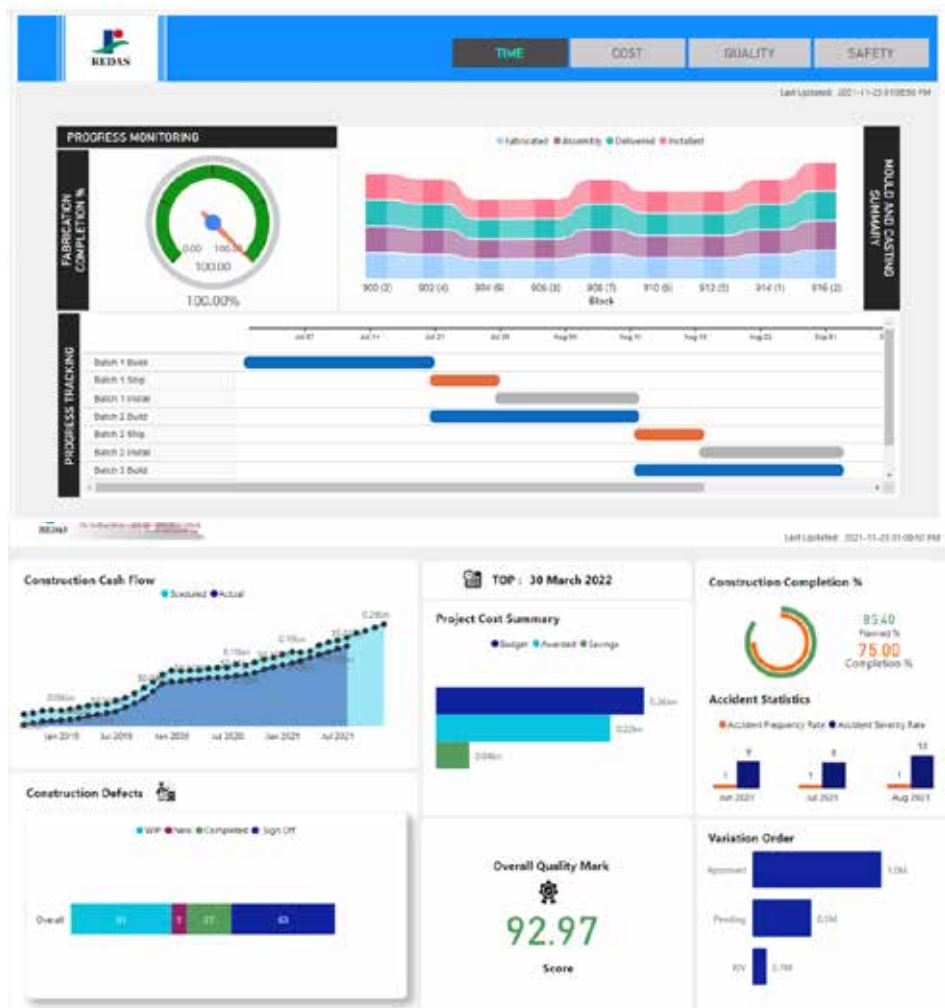
■ b. Ensure that the 8 pilots will cover big, mid-tier and small developers and taking in their value chain feedback/ requirements where possible. The goal is to create a configurable dashboard platform that can be customized for different user needs. It is envisaged that smaller developers are mostly ad hoc users and like the management of architect firms or contractors may

use the dashboard only occasionally to monitor project progress.

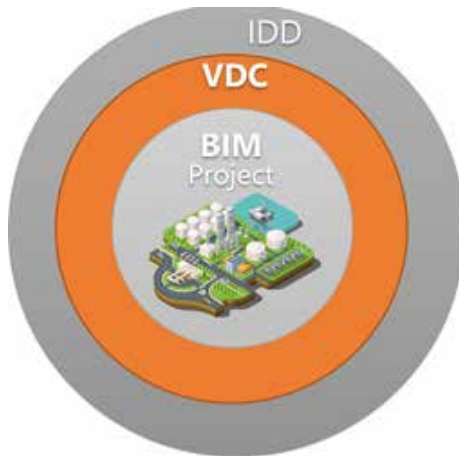
■ c. While the survey and interviews showed that developer-led IDD projects have a better chance of success, the reality is that not all projects especially the smaller ones will readily follow this trend. Therefore, there is a need to highlight the benefits and advantages (as well as provide possible solutions on how to overcome the challenges and difficulties) in the IDD implementation guide to encourage big and small developers to take the lead.

To design the Developer-Centric Dashboard SJ and S3 were tasked to provide a proof-of-concept solution to show the power of information management and monitoring, to encourage more developers to go digital and also in a collaborative manner. The success of this POC can open and broaden the minds of developers to the benefits the dashboard can bring to the industry. With better information available, there are 3 possible digital outcomes we may eventually realize from the spin-offs in the longer term as follows:

1. Better digital workflow to facilitate better integration amongst various different platforms in the future;
2. Better quality data to establish a single source of truth which eventually promote a more conducive environment for BIM collaboration; and
3. Transform the entire industry by encouraging mass adoption based on a best practice IDD road map to facilitate individual organizations in their IDD journey.



In summary, digital transformation can only be achieved if government and every player work together in a structured and collective manner to shift the paradigm. A Chain is Only As Strong As The Weakest Link. Thus, we will need to bring more players with similar capabilities on board and continue encouraging and pushing in this direction. The Developer-Centric Dashboard project has the potential to jump-start this process with developers leading the value chain. Source: KPMG



### 5.51 IDD & BEP

The intent of IDD Execution Plan (& similar to BEP which is a separate document) is to provide a framework for all the stakeholders of the project, including architect/s, engineer/s, owner/s & design/construction managers to deploy Integrated Digital Delivery & Building Information Modelling (BIM) processes & technologies to deliver project to its desired intents(quality), client expectations, planned time-lines & at the same time to be with in the budget.

This document IDD Execution Plan is a live document, which means that it can be revised along the time-line for the planning and execution of this project. This document also delineates roles and responsibilities of each stakeholders of the project, projects objectives, IDD KPI's etc.. The typical contents of a IDD Execution plan is shown below in the table below:

1.0 IDD Framework for Project	2.6 Digital Fabrication
1.01 IDD Framework for Project	2.61 Scope of Digital Fabrication in Project
1.02 IDD Execution Plan Purpose & Organisational Objectives	2.62 IDD Goals for Digital Fabrication
1.1 IDD Overview	2.63 Advantages and benefits of DfMA
1.12 IDD Benefits & Values	2.64 Scope & Responsibility matrix - DIGITAL FABRICATION
1.11 Introduction - IDD builds on BIM & VDC	2.65 Software / Solutions and Tools Used in Digital Fabrications
2. 0 IDD Deployment in Project	2.66 Base Digital fabrication Requirements for Project
2.01 Executive summary	2.7 Digital Construction
2.02 Project Objective	2.71 Scope of Digital Construction in Project
2.1 IDD Processes	2.72 IDD Goals for Digital Construction with methodology and Deliverables
2.11 IDD Value Chain for Project	2.73 Scope & Responsibility matrix - DIGITAL CONSTRUCTION
2.2 Project IDD Requirements	2.74 Software / Solutions and Tools Used in Digital Construction
2.21 Project IDD Requirements >> BCA Initiatives for selected processes	2.75 Base Digital Construction Requirements for Project
2.22 IDD Processes - Requirements & Scope for the selected processes	2.8 Digital Asset Management
2.3 IDD KPI's for Project	2.81 Scope of Digital Asset Management in Project
2.4 BIM Standards for Project	2.82 Digital Assets Creation and Management
2.5 Digital Design	2.83 Scope & Responsibility matrix - DIGITAL ASSET MANAGEMENT
2.51 Scope of Digital Design in Project	2.84 Software / Solutions and Tools Used in Digital ASSET MANAGEMENT
2.52 IDD Goals for Digital Design	2.9 Digital Plan Work (DPW)
2.53 Digital Design Workflow	Appendix A -IDD User Experience
2.54 Base Digital Design Requirements for Project	Appendix B -IDD Framework
2.55 Common Data Environment	Appendix C -Project Dashboard
2.56 Scope & Responsibility matrix - DIGITAL DESIGN	Appendix D -CDE Workflow
2.57 Software / Solutions and Tools Used in Digital Design	Appendix E -IDD Master Check List
2.58 BIM model Deliverables by Stakeholders	



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Employer's Information Requirements

### 5.61 EIR

Exchange Information Requirements (EIR) will support the implementation of Building Information Modelling (BIM) and its related processes in the Project. The EIR document is a sub-set of the Developers/ Employer's Requirements or equivalent contract documentation and introduces information requirements, reasons and purpose to the Project Team/s or Principal Supply Chain Partner/s, along with technical, management and commercial aspects, that need to be addressed. Following table shows a typical content of a EIR for a commercial project:

#### 1 1 Introduction

- 1.1 Document Purpose
- 1.2 Document Structure
- 1.3 Responding to this document

#### 2 2 Project Particulars

#### 3 3 BIM Vision and Objectives

#### 4 4 Strategic Application

- 4.1 IDD Requirements (Optional)

#### 5 5 Information Requirements

- 5.1 Information Exchanges, Project Deliverables and Information
- 5.2 Information Delivery Plan
- 5.3 Level of Definition
- 5.4 Health & Safety -Construction Design Management - Asset Information

#### 6 6 Management

- 6.1 Standards
- 6.2 Roles and Responsibilities
- 6.3 BIM Uses
- 6.4 Soft Landing
- 6.5 Collaboration Processes
- 6.6 Planning the Work and Data Segregation
- 6.7 Data Security
- 6.8 Coordination and Clash Detection Process
- 6.9 Compliance Plan (Quality Assurance)
- 6.10 Delivery Strategy for Asset Information
- 6.11 MIDP and Project Time line
- 6.12 Training

#### 1 7 Technical

- 7.1 Software Requirements
- 7.2 System Performance
- 7.3 Data exchanging format
- 7.4 Co-ordinates

#### 2 8 Commercial

- 8.1 Information Delivery Plan
- 8.2 VDC Requirements
- 8.3 Issuing of Models
- 8.4 BIM Execution Plan
- 8.5 BIM Specific Competence Requirements
- 8.6 Risk Allocation
- 8.7 Intellectual Property Rights
- 8.8 Electronic Data Exchange
- 8.9 Termination, Recission or Expiry of Principal Agreement

#### - APPENDIX

- Appendix A: Key Terms and Definitions
- Appendix B: BIM Particulars Conditions
- Appendix C: Roles and Responsibilities
- Appendix D: Information Delivery Plan
- Appendix D1: Contacts Attribute Data
- Appendix D2: Facility Attribute Data
- Appendix D3: Room/ Space Data Requirements
- Appendix D4: Performance Data Requirement
- Appendix D5: Operational Attribute Data
- Appendix D6: Model Content Plan
- Appendix E: Construction & As-Built Model
- Appendix F: BIM Uses
- Appendix G: Plain Language Questions
- Appendix H: Model Export Protocol
- Appendix I: Detailed BIM/VDC Responsibilities
- Appendix J: References

# 5.7

## Appendix Basic CDE Setup

### 5.71 CDE Common Data Environment

The common data environment (CDE), is the single source of information used to collect, manage, disseminate and document, the graphical model and non-graphical data for the whole project team. Creating this single source of information facilitates collaboration between project team members & helps avoid duplication/mistakes. Common Data Environment, is implemented by default for each project. Normally, when a project is created it creates four, CDE folders:

WIP	Shared	Published	Archived
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The WIP folder is where the teams will do most of their work. Beneath the WIP folder you can create as many folders as you need to structure your data in the most appropriate manner. This may typically be by discipline, such as MEP, Structural, Architectural and Civil. The user can then assign ISO-19650 workflow to the folders. The workflow contains the following states:

**Example ..** Work in Progress, To be Checked, To be Verified, To be Approved, Completed

CDE is intended to support the collaborative production, management and sharing of architectural, engineering and construction (AEC) information, using BIM level 2 maturity. All BIM work undertaken corroboratively between the design team members identified in the roles defined in ISO-19650-Part2 (PAS1192-2:2013) are centrally stored in this repository. It is intended that the stakeholders of the project and their internal procedures support the roles defined here in the interest of project quality control and improving collaborative processes.

The CDE contains:

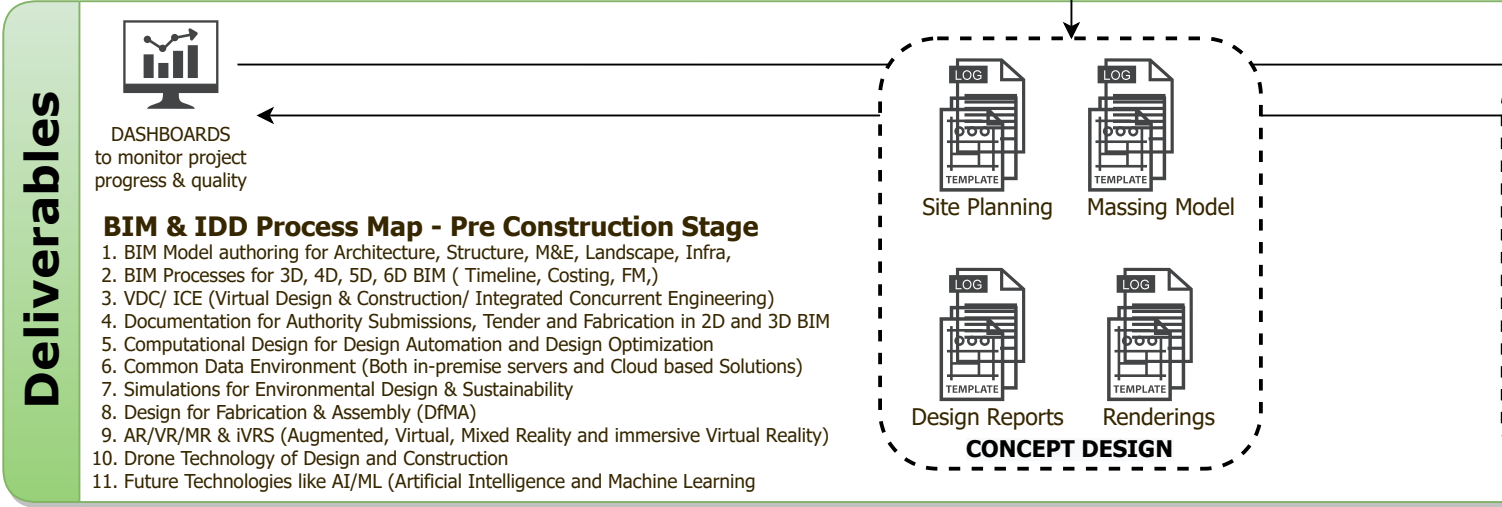
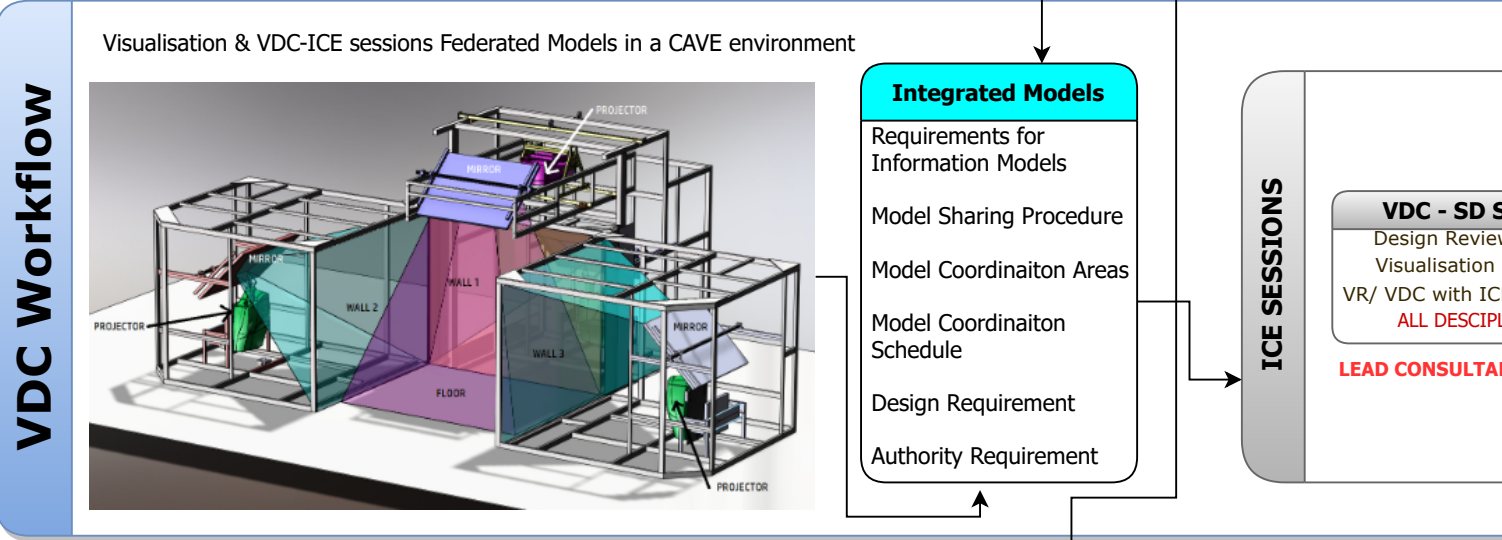
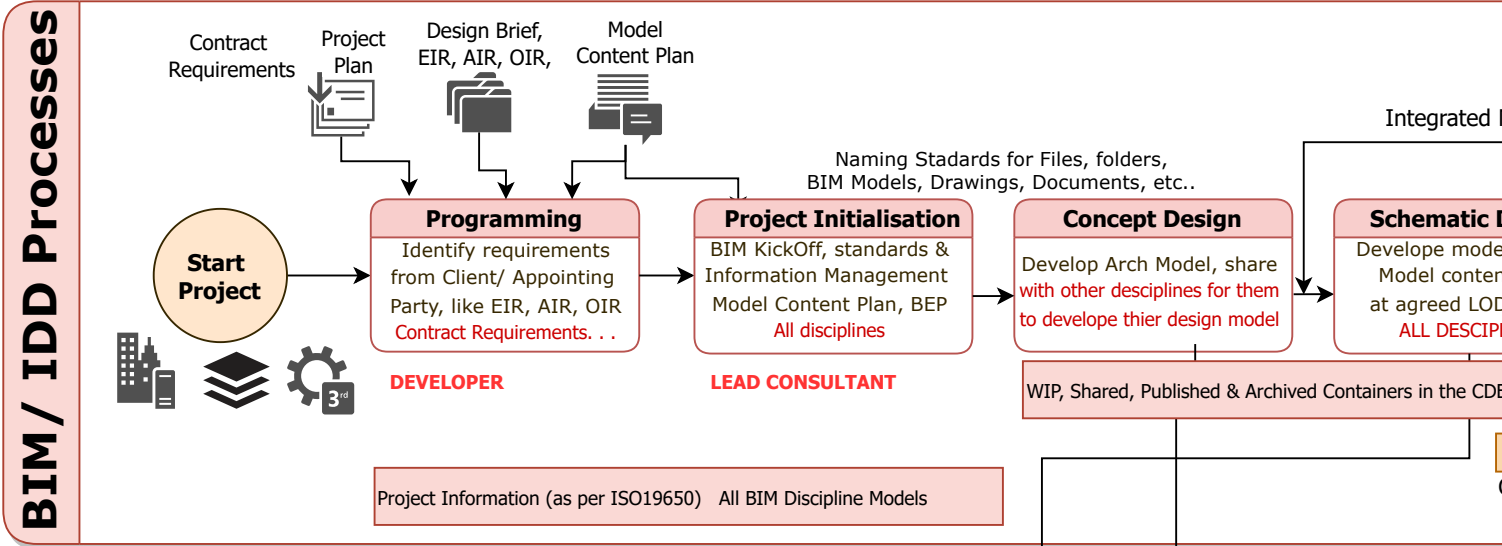
- Graphical Data (models, drawings, IFC, ...)
- Non-graphical Data (schedules, databases, etc..)
- Documents (contracts, minutes, RFI's, brief, specifications, reports, BOQ, inspection plans, commissioning certificates, product data sheets, user manuals etc)

Collectively this information is called the Project Information Model (PIM) during design /construction phase, and once handed over, the Asset Information Model (AIM) for operations phase (The word "model" in these terms should not be confused with only the 3D model)

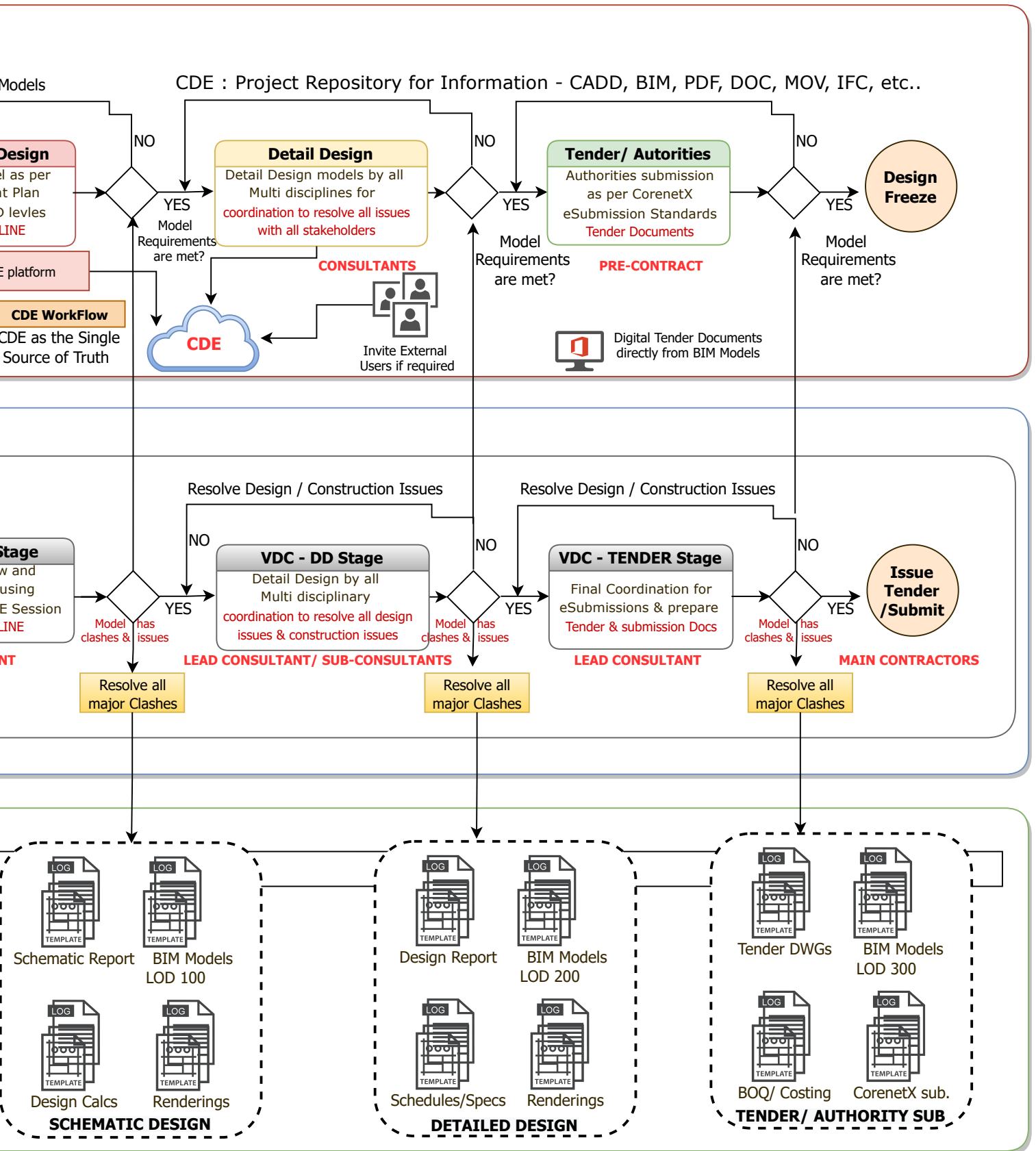
## Common Data Environment

*Controlled access in a container based project repository*





# Appendix



<b>SOME OF THE INTERNATIONAL BIM STANDARDS AS OF 2022</b>	
ISO 19650-1:2018	Organisation & Digitalization of information about Buildings & Civil Engineering Works including BIM – Concepts & Principles
ISO 19650-2:2018	Organisation and Digitalization of Information about Buildings & Civil Engineering Works including BIM – Asset Delivery Phase
ISO 19650-3:2020	Organisation & Digitalization of Information about Buildings & Civil Engineering Works including BIM - Operational phase
ISO 19650-5:2020	Organisation & Digitalization of Information about Buildings & Civil Engineering Works including BIM Security -minded approach
ISO/DIS 19650-4	Organisation & Digitalization of Information about Buildings & Civil Engineering Works including BIM - Information Exchange
PD 19650-0:2019	Transition Guidance to ISO 19650
PAS1192-3:2014	Specification for information management for the operational phase of assets using building information modelling.
BS1192-4:2014	Collaborative production of information. Fulfilling EIR's requirements using COBie. Code of practice.
PAS1192-5:2015	Specification for security-minded building information modelling, digital built environments and smart asset management.
BS 8536-1 - 2015	Briefing for design and construction – Part 1: Code of practice for facilities management (Buildings infrastructure).
BS 8536-2 - 2016	Briefing for design and construction – Part 2: Code of practice for asset management (Linear and geographical infrastructure).
PAS 91:2013	Construction Pre-qualification Questionnaires.
BS8541-1:2012	Library Objects for architecture, engineering and construction. Identification and Classification – Code of practice.
BS8541-2:2011	Library Objects for AEC Recommended 2D symbols of building elements for use in building information modelling.
BS8541-3:2012	Library Objects for architecture, engineering and construction. Shape and Measurement. Code of practice.
BS8541-4:2012	Library objects for architecture, engineering and construction. Attributes for specification and assessment. Code of practice.
BS8541-5:2015	Library objects for architecture, engineering and construction. Part 5: Assemblies – Code of practice.
BS8541-6:2015	Library objects for architecture, engineering and construction. Part 6: Product and facility declarations – Code of practice.
BS ISO10007:2015	Quality management systems. Guidelines for configuration management.
BS ISO16739:2013	Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries.
BS 7000-4:2013	Design management systems. Guide to managing design in construction.
ISO 44001:2017	Collaborative business relationships management system
BS ISO 29481-1:2010	Building information modelling. Information delivery manual. Methodology and format.
BS ISO 29481-2:2012	Building information models. Information delivery manual Interaction framework.
BS ISO 16739:2013	Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries.
BS ISO 12006-3:2007	Building construction. Organization of information about construction works. Framework for object-oriented information.

# Appendix

## Glossary of Words

Aggregate Model	A Model consisting of linked but distinct component Models, and/or drawings derived from other models, or other data sources.
BIM	Building Information Modelling (BIM): the creation and use of coordinated, internally consistent, computable information about a project in design and construction. In this document these terminologies are specifically related to Revit Authoring.
Building Information Model(s):	A digital representation of the physical and functional elements of a Project. This term may be used to describe a Model Element, a single Model or multiple Models linked together.
Building Information Modelling(BIM)	The process and technology used to create a BIM Model by authoring tools like Revit, Graphisoft, AECOsin, etc..
Central Files in Revit Authoring	The Central file is created the first time you save the project after sharing it. This file stores the current ownership information for all the Worksets in the project. The central file acts as the distribution point for publishing work to the rest of the team. All users should save their own local copies of the file, work locally, and then save changes back to the central file for other users to see their work.
Construction Coordination Model	A Model managed by the General Consultant during later design stages where sub-consultant models can begin to replace portions of the Design Model. The main purpose of this model is to aid in the coordination and the detection of interferences between building components/disciplines
Coordinates in Revit Authoring	Two coordinate systems in a Revit project: project internal and shared. Each system has essential features and limitations. Project Internal Coordinate System : Every Revit project has an internal coordinate system referred to in several places as Project. The project coordinate system cannot be changed. Shared Coordinates : The shared coordinate system consists of a single origin and true north orientation which can be synchronized between models and even AutoCAD drawings.
Design Model	A Model created by the architecture and engineering disciplines to establish the general design of the project. Generally produced by Consultants
Families in Revit Authoring	A family is a group of elements with a common set of properties, called parameters, and a related graphical representation. Different elements belonging to a family may have different values for some or all of their parameters, but the set of parameters (their names and meanings) is the same. These variations within the family are called family types or types. There are 3 types of Revit Families – System Families, Component Families and In-Place Families.
Model User:	Refers to any individual or entity authorized to use the Model on the Project, such as for analysis, estimating or scheduling or construction.
Object Styles in Revit Authoring	The Object Styles tool specifies line weights, line colours, line patterns, and materials for different categories and subcategories of model objects, annotation objects, and imported objects in a project. You can override project object styles on a view-by-view basis with Visibility Graphics.
View Types	Defines some graphics properties, such as a reference label and tags for elevations, callouts, or sections. It can also specify a view template to apply to a new view, and whether template updates should be applied to existing views.
View Templates in Revit Authoring	A view template is a collection of view properties, such as view scale, discipline, detail level, and visibility settings. Use view templates to apply standard settings to views. View templates can help to ensure adherence to office standards and achieve consistency across construction document sets.
View Range in Revit Authoring	Every plan view has a property called View Range, also known as a visible range. The view range is a set of horizontal planes that control object visibility and display in the view. The horizontal planes are Top, Cut Plane, and Bottom. The top and bottom clip planes represent the topmost and bottommost portion of the view range. The cut plane is a plane that determines at what height certain elements in the view are shown cut. These 3 planes define the primary range of the view range.
Views/ Sheets - Revit	Rendition of graphical or non-graphical information to a defined scale (a plan, section, elevation, schedule, or other views).
Visibility Graphics in Revit Authoring	The visibility and graphics settings of a view define whether elements and categories are visible in the view and their graphical appearance (colour, lineweight, and linestyle). The Visibility/Graphics Overrides dialog lists all categories in the project. Some examples of categories are furniture, doors, and window tags. The visibility status and appearance of each category can be modified for each view in the project. Use the context menu to modify the appearance and visibility of individual elements.



**REDAS**

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