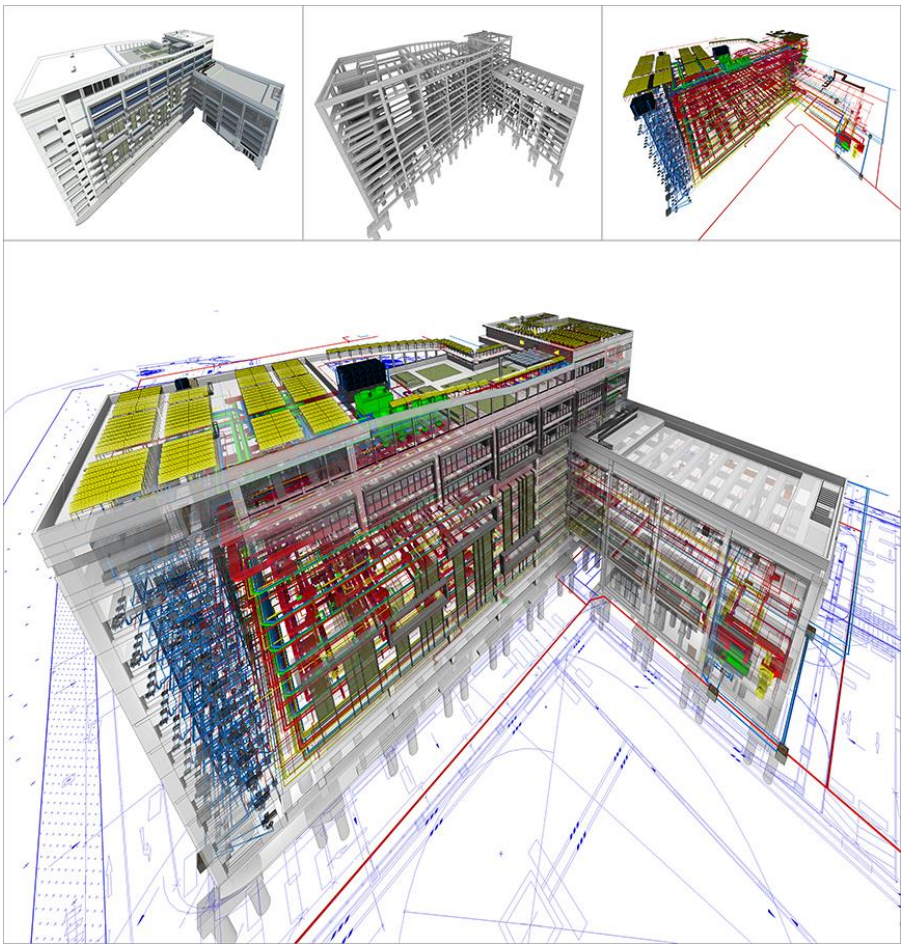
Building and Construction Authority

BIM Guide for Asset Information Delivery



Version 1.0

BCA acknowledges the leadership provided by the IDD Steering Committee in support of the production of the Building Information Modelling (BIM) Guide for Asset Information Delivery.

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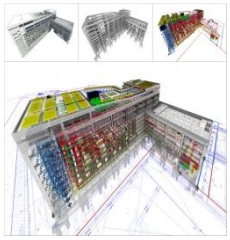

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CEO's Message

Dear readers,

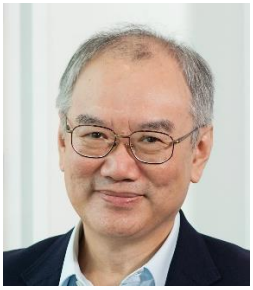
The Integrated Digital Delivery (IDD) Implementation Plan for Singapore's Built Environment was launched in November 2018 with an aim to extend the value of Building Information Modelling (BIM) to the entire building lifecycle, especially for the asset delivery and management processes. This will help our asset owners derive more value of their physical assets i.e. the completed building, by enhancing its operations and maintenance with the help of digital technology and information.

The BIM Guide for Asset Information Delivery is a timely effort in defining the asset information requirements from both the owners' and operators' perspectives. The requirements will guide the project consultants and contractors in preparing the digital information model suitable for asset operations and maintenance. The Guide will set out the much needed information requirements to be delivered at handover for facility management.

I would like to thank the BIM FM Workgroup, involving the various industry stakeholders, for their contribution to this Guide.

Mr Hugh Lim

IDD Steering Committee Chairman's Message



Dear readers,

Since 2010 when Singapore started on its Building Information Modelling (BIM) journey, we have made significant progress for the design and construction phases of projects. It is timely that we make sure that the information in the BIM models built up over these 2 phases meets the requirements for use during the operations phase of the projects. This guide serves to do that. It is to be used by Project Owners/Developers and their Asset Management/Facilities Management (AM/FM) staff to define the framework and detail requirements for the information on their assets.

Using BIM for AM/FM can improve productivity of the operations, firstly, through ease of retrieval of asset information and building plans. Secondly, BIM can facilitate better scheduling of maintenance, repair and renovation works simply through visual inspection as many of the building elements or systems are physically clustered together. For smart buildings, the functionalities of various systems are likely to be interdependent and BIM can enable simulation to avoid unexpected disruptions during actual works.

The level of data integrity will be strengthened as changes or update of data such as as-built can only be done with proper authorization. Inconsistency between actual site data and BIM data can also be quickly identified and highlighted for ratification.

The Construction Industry Transformation Map (ITM), which was launched in October 2017, and Integrated Digital Delivery (IDD) Implementation Plan which have been introduced this year, place emphasis on Integrated Digital Delivery (IDD) as one of the key thrusts that looks at the whole-life cycle approach of building projects ending with digital assets to facilitate integrated operations and maintenance. This will allow the whole industry to enjoy the fruits of productivity increase with better quality and sustainability.

I would like to encourage all Owners/Developers to make full use of this guide to specify up front their requirements for the asset information that their staff will need to operate and maintain their assets properly. They should extract maximum utilisation out of their investments.

I would also like to take the opportunity to thank all the organisations and individuals who have given generously of their time to produce this guide.

Er Lee Chuan Seng

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PREFACE

WHAT THIS GUIDE IS ABOUT

Singapore has started the Building Information Modelling (BIM) journey in 2010. Many consultants and contractors have embraced the use of BIM for their projects. To maximise the use of BIM, building/facility owners can capitalise on the rich information developed in the process for operation and maintenance purposes. Increasingly, we have also seen more building/facility owners beginning to look at using BIM for asset management.

For BIM to be effective for life-cycle asset management, it is important at the start of the project to understand what information is important to capture upfront for use in later project lifecycle stages.

This Guide[1] provides a framework for building/facility owners to define their information requirements to be captured using BIM application at design and construction stages and enable the owner to use the information for operations and maintenance.

[1] This Guide does not define the information requirements for rail infrastructure project.

HOW THIS GUIDE IS ORGANISED

The Guide has three main sections.

The **first section** gives a broad overview on BIM and the benefits of BIM for asset management.

The **second section** elaborates the steps of how BIM could support delivery and management of asset information for a BIM-enabled project, describing the “what and how to do it”.

The **third section** covers other areas for consideration in implementing BIM for asset management solutions.

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1. INTRODUCTION

1.1 WHAT IS BIM

BIM stands for **B**uilding **I**nformation **M**odelling.

BuildingSmart International defines BIM as follows:

“BIM is a digital representation of physical and functional characteristics of a facility. A building information model is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition”.

BIM is all about data that is built up starting from the design, to construction and finally to the operations and maintenance phase. Both geometry and non-geometrical data describing building elements are found in BIM.

More information and essential guides on BIM can be found on **corenet.gov.sg.**

1.2 WHY BIM FOR ASSET MANAGEMENT

The goal of facility managers primarily is to manage the buildings and facilities effectively and efficiently in line with the owners’ objectives, in compliance with the law and safety considerations, being energy-efficient and ensuring the availability of building services to the occupiers with the aim of enhancing the asset values.

FM managers and technicians need building information to discharge their duties effectively and efficiently. Traditionally, FM Managers depend on as-built drawings and

Operational & Maintenance manual. Such practice is no longer meeting the fast and demanding modern business world especially with the adoption of BIM.

Building/facility owner should capitalise on BIM and its information available and move forward in adopting BIM for Asset Management (BIM-AM) that will gain substantial benefits in terms of cost, safety, productivity and efficiency when the building or the facilities start operations.

To cross over from BIM to BIM-AM it is important that information that are key to effective operations and maintenance are accurate and completely built into the BIM. A problem today at handover stage is the inconsistency of hand-over information that makes it very challenging for the recipient to organise and subsequently use the information effectively for asset management.

With BIM, information can be captured and presented in a structured manner and it can be digitally accessed and managed more conveniently compared to hardcopy documents. Manually entering asset data into AM systems will be a thing of the past. BIM data can also be integrated with Smart building solutions in a seamless manner facilitating the establishment of a predictive and preventive maintenance regime. BIM can help facility managers to access digital information within minutes as compared to possibly taking hours to retrieve the same information without BIM.

2. ENABLING BIM FOR ASSET INFORMATION DELIVERY

2.1 FRAMEWORK TO USE BIM FOR ASSET MANAGEMENT

The key to effective BIM for asset management (BIM-AM) is to understand the asset information requirements which are critical for the operations and maintenance (O&M) phase. Asset management is about managing assets to achieve better O&M and the life cycle of critical assets. Hence it is essential that building/facility owners should ensure building asset information are captured accurately during the design as well as construction stages. To ensure this is done proficiently, it is important to **define the information requirements at the start of the project.**

The framework presented in this Guide (as illustrated in Figure 1) proposes an approach to define and capture asset information for a BIM-enabled project. This Guide also prescribes how these asset information can be linked to FM systems but do not cover the technical connections and configurations in detail as this varies according to the FM solutions deployed on site. Typically data can be passed on to such FM solutions via direct integration or flat file transfer.

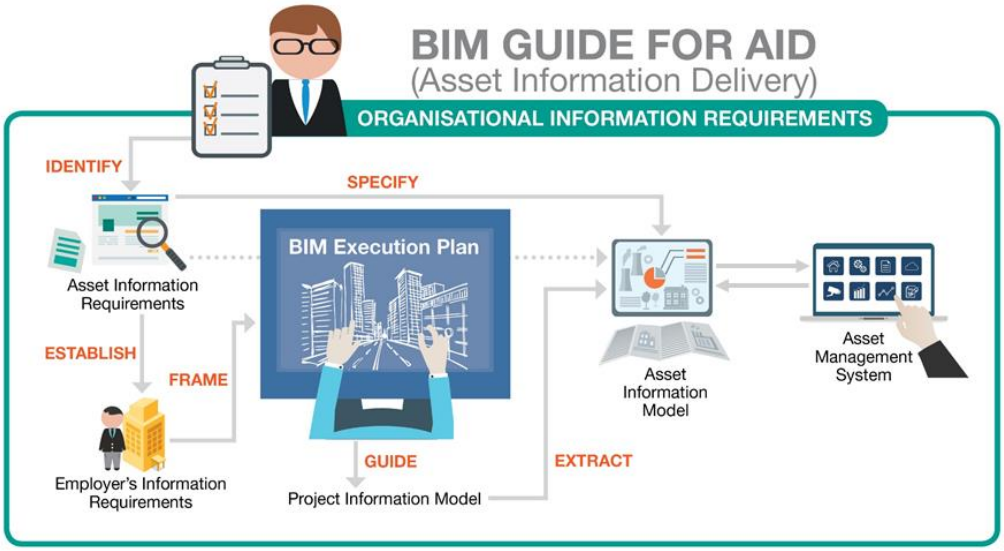

Figure 1 Framework - BIM for Asset Information Delivery

References:

1. **Singapore BIM Guide version 2**
2. **UK PAS 1192-2:2013 – Specification for information management for the capital/delivery phase of construction projects using building information modelling**
3. **UK PAS 1192-3:2014 – Specification for information management for the operational phases of assets using building information modelling**

Organisational Information Requirements (OIR) – the information which the organisation need to know in order to run the business.

Assets Information requirements (AIR) – the information the organisation need to know about its assets it is responsible for.

Employer Information Requirements (EIR) – Sets out the information to be delivered, the standards and processes to be adopted for a construction project.

BIM Execution Plan (BEP) – Outlines the overall vision and along with implementation details for the project team to follow throughout the project.

Project Information Model (PIM) – information model developed during the design and construction phase of a project.

Asset Information Model (AIM) – is a model that compiles graphical and non-graphical data and information as well as documents and metadata necessary to support asset management.

Basically there are 3 key elements in the data management framework for BIM-enabled asset information delivery project which will be discussed in the subsequent sub-sections:

1. **Information Requirements** (OIR, AIR, EIR) by the facility/building owner
2. **Information Delivery** (BEP, PIM, AIM) by the project team
3. **Information Exchange** across project lifecycle by all project stakeholders

2.2 INFORMATION REQUIREMENTS

In this section, a step-by-step approach is proposed to assist building/facility owner in defining and translating the information requirements at the strategic level (OIR) into the information requirements at the operational level (AIR) and how it could be specified in the tender specification (EIR). Figure 2 gives an illustration of this approach while Table 1 proposes potential parties involved in the development of the information requirements.

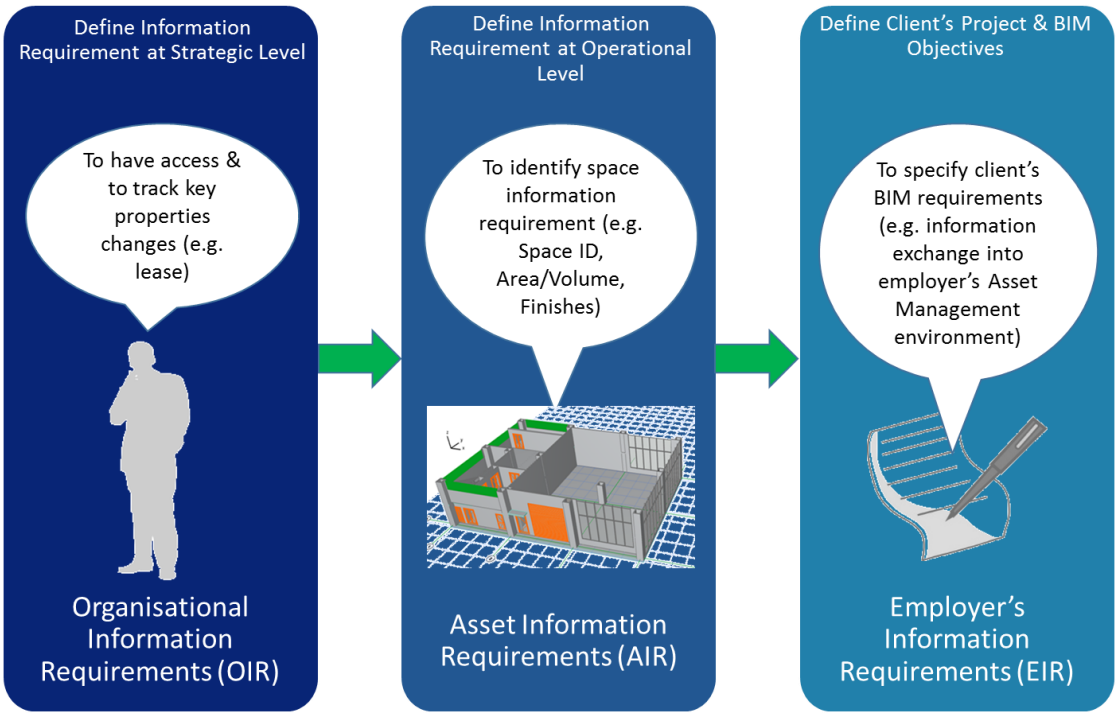

Figure 2 Information Requirements Specification

Table 1 Parties Involved in Information Requirements

Information Requirements	Potential Parties Involved in defining the Requirements
Organisational Information Requirements (OIR)	• Estate Manager • Property Manager • Facility Manager
Asset Information Requirements (AIR)	• Estate Executive • Property Executive • FM Executive
Employer's Information Requirements (EIR) or Client's BIM Requirements	• Legal Department • IT Department • Estate/Property/FM Department

2.2.1 Organisational Information Requirements (OIR)

The OIRs describe the information required by an organisation for asset management and operation and other organisational functions at a strategic level. Ideally before a building/facility owner request for the asset information delivery from their project team, it is necessary to understand "who" need the information and "why" the information is needed to avoid it becoming a case of "information for information sake". Given the inherent costs for every information capture, the reasons for asking each information should be well understood on how it adds value to the organisation.

To define the OIRs, it is important to understand the business process along with the business unit responsibilities; hence identifying the OIRs may require input from various departments within the organisation. A method for drawing out these requirements is to ask why the information is needed at each point of a process. For example, a tenancy manager would need to provide a client with suitable information regarding potential vacant space so that the client could make an informed decision on a property. In order to do that, the manager would need **to have access and be**

able to track key property changes (e.g. lease expiry date and floor space occupied) which will be one of the OIRs for this particular use case (see **ANNEX A** for more example on OIR).

2.2.2 Asset Information Requirements (AIR)

Once the business needs are understood, more detailed asset information requirements (AIRs) can be defined. Based on a list of asset types that matter to the building/facility owner, the initial requestor of the information should be able to define the specific asset information required to achieve the objective defined in the OIRs. Typically, the asset information would include the following:

- Physical asset data – name, description, and technical characteristic of the asset
- Location and spatial data – where the asset is and how it relates to other assets
- Performance data – how this asset contributes to the serviceability target
- Condition data – what is the life expectancy of the asset

For the operation and maintenance purposes, the key assets are usually those associated with the space and building services system. The following shows examples of the asset systems to be captured for the deliverables (see **Annex B** for more detailed examples):

1. Architectural Systems
2. Conveyance Systems
3. Safety/Security Systems
4. Information Technology System
5. Mechanical Ventilation Systems
6. Building Automation, Monitoring, Space Control
7. Air-conditioning and Refrigeration Function
8. Plumbing and Sanitary Systems
9. Building Envelope System

10. Gas Systems
11. Electrical System

To assist facility/building owner in identifying which assets are important for the operation and maintenance, the following criteria could be used:

- Asset components with high frequency usage and wear and tear that require a regular or unpredicted period of monitor, maintenance and replacement
- Asset components that are linked directly to the basic and common services of a building e.g. ventilation, air-condition and drainage system, etc
- Asset components that require specific information such as health and safety operation environment and procedure

Asset owner is recommended to involve the FM practitioners early during the setting up of AIR.

2.2.3 Employer's Information Requirements (EIR)

The **Employer's Information Requirements (EIR)** (also known as client's BIM requirements) is a document that defines the client's project and BIM objectives. The EIR generally outlines the information to be delivered, together with any associated standard and process to be adopted by the project delivery teams. It will also establish the scope of work for the engaged project team to create the data in a structured manner (see **ANNEX C** for more example on EIR).

The detailed approach to be taken, including defining the roles and responsibilities of the key stakeholders in the value chain that need to create the asset data, should be spelled out later in the **BIM Execution Plan (BEP)**.

2.3 INFORMATION DELIVERY

Based on the information requirements specified in the EIR, the project team would start to plan on how to collect, coordinate, and deliver the asset information. In this section, typical information deliverables will be discussed as summarised in Table 2.

Table 2 Information Deliverables

Deliverables*	What it is and When to be delivered?
BIM Execution Plan (BEP)	• A document to explain in detail how the project team plan to meet the requirements specified by the building/facility owner • To be delivered before the project started
Project Information Model (PIM)	• A progressively developed information models (BIM and non-BIM) across the project lifecycle (e.g. Coordinated Design Model → Construction Model → As-built Model) • To be delivered at different project stages/milestones
Asset Information Model (AIM)	• An information models (BIM and non-BIM) derived from PIM that supports the ongoing management of an asset • To be delivered during project handover

*To be delivered by consultants and/or contractors & suppliers

2.3.1 BIM Execution Plan (BEP)

BIM Execution Plan (BEP) is a document prepared by the BIM Manager and maintained along with the project progress as a live document to explain in detail on how the project team plan to meet the Employer's Information Requirement (EIR) specified by the building/facility owner. In the Asset Information Delivery strategy, the consultants and contractors should propose:

- The roles and responsibilities of the parties and individuals for asset information modelling and management of the project;

- The processes and procedures to collect, coordinate, and deliver asset information;
- The process for validating accuracy and submitting/applying corrections to asset information model;
- The process and procedure to share the asset information model among project team members and cross parties;
- The process for updating the asset information model;
- The procedure on their quality assurance processes for Data, Models and Documents;
- Response to the client's specific requirements, confirming the ability to comply on the timing, content, and format of information delivery;
- Comments where deliverables are impractical to deliver with alternative delivery proposals;
- If aftercare is required, the contractor must specify the period of aftercare (the number of years that the model should be managed for) following handover.

More details on the BEP can be found in the Singapore BIM Guide (corenet.gov.sg).

Reference: Singapore BIM Guide Version 2 (www.bimsg.org)

The Singapore BIM Guide Version 2 outlines the various possible deliverables, processes and personnel/professionals involved when BIM is being used in a construction project.

Users can use this BIM Guide to clarify the roles and responsibilities of project members when using BIM in a construction project. The roles and responsibilities are then captured in a BIM Execution Plan (BEP), to be agreed between the Employer and project members.

2.3.2 Project Information Model (PIM)

Project Information Model (PIM) is an information model developed during the design and construction stage of a project. Using BEP as a standard and procedure guideline, the PIM will evolve from the most initial concept design to the virtual construction model to support construction stage activities and delivered as Asset Information Model (AIM) during project handover.

Project information (e.g. BIM data) usually evolve when the project progresses from the conceptual design stage to the O&M stage. Some data that is specific to a particular stage (e.g. alternative design options in design development stage) will not be brought over to the next stage as it may not be relevant or useful for the following stage to work on it. On another hand, Lifecycle data such as asset information will continue to grow along with the progress of the project when the design and selection of assets become more certain.

The evolution of Project Information Model will generally go through the following phases as shown in **Figure 3.**

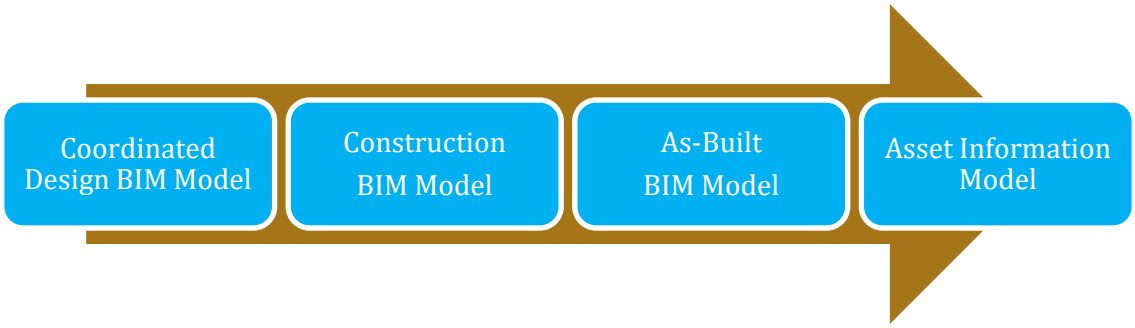

Figure 3 Evolution of data

Coordinated Design BIM Model: The Design Model is created by the design team that captures the intended design.

Construction BIM Model: The Construction Model is developed from the Design Model and is used by contractors for fabrication and construction coordination.

As-Built BIM Model: This Model should capture the condition and relevant information at the end of the construction stage. The building/facility owner should retain the as-built model as the authoritative source and a reference for the building as-constructed.

Asset Information Model: The Asset Information Model (AIM) is derived from the As-Built BIM model where only information specified in the AIR is to be retained.

The building/facility owner should be clear in specifying the timing, the content, and the format of any interim and finalised deliveries. This is to allow the lead consultant and/or lead contractor to prepare and respond appropriately. Table 3 below shows an example of a deliverable schedule and milestones on asset information deliveries.

Table 3 Asset Information Deliverables

Milestone	Asset Information Deliverable	Format
Contract Award	BIM Execution Plan that include asset information delivery plan	PDF
Detailed Design	• Designed Performance of Managed Asset (e.g. cooling capacity of the chillers) • Location of Managed Asset	Native BIM Format + Excel
Construction	All other asset information as specified in Annex B	Native BIM Format + Excel

The final details for consultant and contractor deliverables are to be included in the agreed project BIM Execution Plan (BEP), and this could also inform the production and delivery of the Asset Information Model that meets the building/facility owner or client's requirements.

2.3.3 Asset Information Model

As asset information is essential for business operations, it is important to have a process to ensure the collection and management of good quality and accurate data. Therefore this section defines the deliverables (either documents, graphical models or drawings) to be produced by the project team at the end of the project, named as Asset Information Model (AIM).

The AIM deliverables usually comprise BIM and non-BIM deliverables. The BIM deliverables consist of a set of BIM models (e.g. architectural model, structural model and plumbing model, fire protection model, ACMV model, electrical model, etc.) where each of the models contains geometric representation of the BIM Elements and their

selected non-geometric attributes. The non-BIM deliverables usually consist of other asset information documents (files in PDF, JPEG, XLS, databases, etc.) that are linked and referred by the BIM deliverables. Figure 4 shows the structure of Asset Information Model.

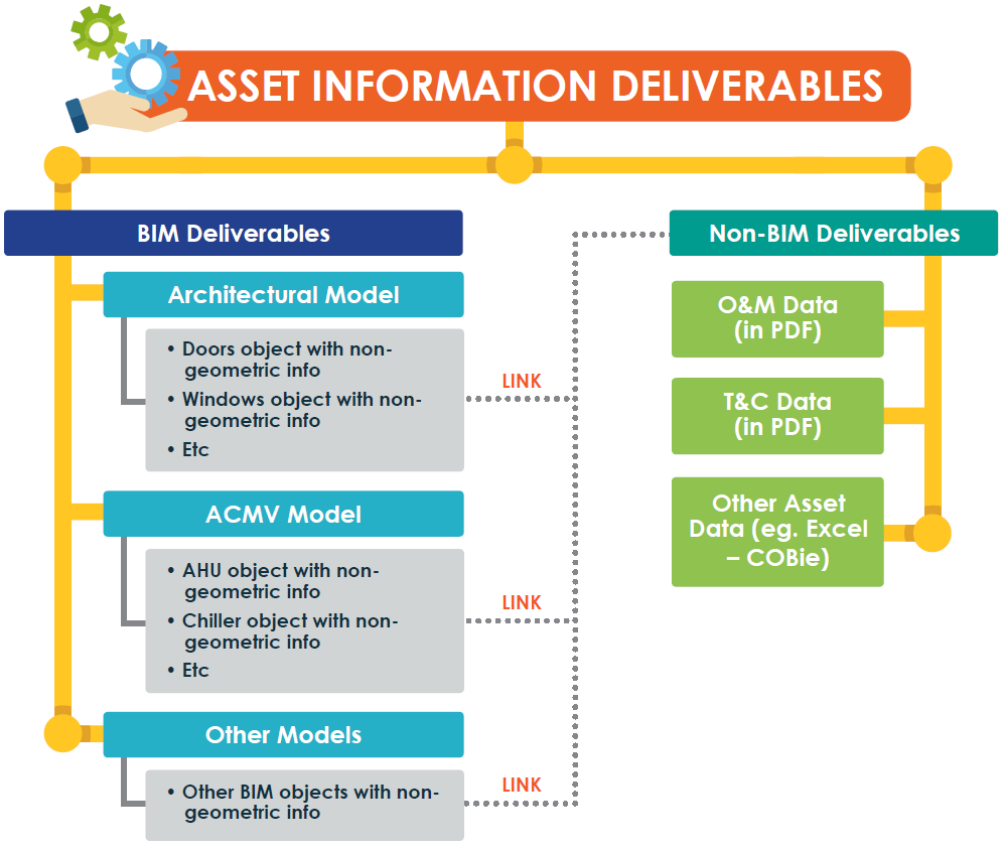

Figure 4 Asset Information Model

2.3.3.1 BIM Deliverables

The BIM deliverables usually consist of the geometric elements (e.g. assets to be modelled) and the non-geometric data (e.g. asset information to be tagged as parameter in the geometric elements). Not all information about a facility needs to be captured within a BIM model. While it is possible to request all assets to be modelled, a building/facility owner needs to understand that for every object included in a BIM model, the file size of the model will increase. The building/facility owner should also understand that the more detail an object is, the bigger file size it will be and the longer it will take to load the model. Over-specifying may cause user to obtain unnecessary

information at an inflated cost and incur higher BIM maintenance cost during operation and maintenance stage. Hence, it is important to know the purpose of having certain objects in a BIM model (e.g. whether that particular asset is actually managed) before putting those requirements in a tender document.

The quality and completeness of the BIM deliverables is vital for the development of a useful Asset Information Model. It is essential to ensure that all geometric elements in a model are classified (using a standard such as Omniclass / Uniclass 2015) and mapped to a client/project specific table of assets that need to be tracked for operations and maintenance, as determined by the building/facility owner. The AIR must reflect the information requirements in the context of the specified table of assets. In addition, the geometric elements shall be verified for the attributes such as those illustrated in Annex A. As the attributes vary by asset type, it is critical that elements are assigned specific classification in greater detail than that offered by BIM authoring platforms in order to meet the needs of operations and maintenance.

As BIM is an iterative process, verification and validation of information requirements shall follow a regular cadence between major data milestones to ensure the data is maturing as expected. A systematic approach to track the development of information in models and an automated process to identify data issues must be considered to provide the building/facility owner the visibility and transparency. A system to ensure that the data owner solves the data issues on a timely manner is also highly recommended. The data verification process shall be repeatedly employed until all the data expectations have been met prior to every data deliverable milestone.

2.3.3.2 Non-BIM Deliverables

Non-BIM deliverables refer to additional asset information such as documents, databases, or cloud storages to be handed over to building owner as specified in the contract. These information are not part of the BIM model but they are essential for the FM practitioners. For example, T&C or O&M documents are usually not embedded in the BIM element but the link to that particular documents could be provided.

Similarly, information provided on databases and cloud-storages will be ‘tagged’ in BIM model to be machine-readable such that software solutions are able to read and relate them.

This type of information usually will be consumed later by a Computerised Maintenance Management System (CMMS) / Computer Aided Facilities Management (CAFM) / Building Management System (BMS) system. Building/facility owner should consult their CMMS/CAFM/BMS vendor on the preferred way in consuming Asset Information Deliverables.

2.3.3.3 BIM Data vs Non-BIM Data

Conventional practice of consolidating asset information has been to insert them into BIM as additional attributes in the drawing elements (or BIM Data). However, this introduces two challenges in project execution.

First, timing of compilation of asset information does not often synchronise with BIM development. Further, it might be necessary to go through multiple revisions of asset information as part of verification and corrections. In this case, BIM has to be modified over and over again, which could be costly, especially if BIM work is outsourced.

Secondly, today’s O&M practice requires much more details about the asset than conventional asset management systems did. Some of these information changes with time and updated frequently. If they are maintained as BIM Data, it will demand BIM to be modified frequently.

Due to this reason, the practice of keeping asset information as non-BIM Data is increasing in popularity. Further, non-BIM Data is much easier to set up for collaboration and data exchange.

2.4 INFORMATION EXCHANGE

The smoothness of information exchange process is essential to the overall success of construction projects. In order for information to be successfully exchanged, it is necessary for all contributors to understand what they need to provide and what others will be providing and how this information will be presented and used. This section will discuss on some fundamental technology for information exchange process.

2.4.1 Common Data Environment

To improve the information exchange and issuing of information that supports the delivery of a project, a common data environment (CDE) or a collaboration platform is recommended. The CDE is a central repository where construction project information is stored and shared. It keeps not only assets created in BIM environment but also documentations related to the assets.

It is likely that the CDE is not a single software application, but a network of systems that meet more complex business needs. The applications within the CDE shall be dependent on the needs of the project and the intent it is supposed to serve. So there may not be one size that fits all.

It is recommended that there is a clear demarcation of ownership between the CDE established by the project team (for collaboration between the design and build firms on the project) and that established by the building/facility owner. The owner's CDE shall be the environment where the supply chain publishes all of their deliverables and the environment where the Asset Information Model is built and maintained.

Building/facility owner should consider the security risks of the protection of data in a CDE by including the data restriction procedures. Roles, permission, as well as the access control of project team members should be defined at the start of the project.

Under this CDE, data processing and handling procedure could be set up. For example, how and what is the frequency of data to be exchanged. Each data update shall be logged in an audit-trail such that any mishandling can be traced back to its source.

2.4.2 Information Exchange Format

Data Exchange formats and protocol should be developed and agreed by all parties collaborating and contributing to the information delivery process. At a project level, information will be required in a format defined in the BIM Execution Plan (BEP), which may include (but not limited) to any of the following outputs:

- Native – 3D discipline model files
- Common file format – IFC model files, per discipline and federated
- COBie

The asset information hand-over, either from designer to contractor or from contractor to building/facility owner, usually comes in the form of paper documents and/or proprietary format. Construction-Operations Building information exchange (COBie) is an open standard format that aims to eventually replace the current paper-based documents with an electronic format. The standard was developed for the exchange of information of managed asset that covers equipment, products, and spaces.

COBie deliverables could be specified in the Employer's Information Requirement and be used as one of the transmittal methods between the client and its service providers. More information and guides on COBie can be found at the Whole Building Design Guide website (www.wbdg.org).

Asset Classification System

For COBie to work, asset classification system needs to be defined upfront. Asset classification system is a systematic and structured approach in classifying objects. It is a hierarchical numbering systems that provide a unique number to describe everything in the building process. The two commonly used classification system are Omniclass (mainly used in the US) and Uniclass (mainly used in the UK).

2.4.3 Information Exchange with Facility Management (FM) Solutions

Specifying the information exchange format for project handover is critical. The asset management team should verify which file/data formats are supported by its asset management software and require the information to be exported from BIM and/or any other AIM sources into that particular format. Most BIM applications could export (and most CMMS/CAFM/BMS platform can import) information in spreadsheet format, however each solution may have a specific spreadsheet layout or data structure that confirms to its proprietary data model.

In general, there are two ways in exchanging asset information deliverables into facility management solutions, e.g. the CMMS/CAFM/BMS platform:

- Direct mapping from BIM platform to CMMS/CAFM/BMS platform (**Figure 5**):

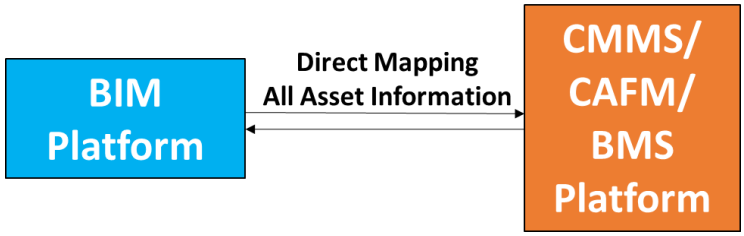

Figure 5 Asset Information Exchange into BIMCMMS/CAFM/BMS

- Only mapping key asset information (**Figure 6**):

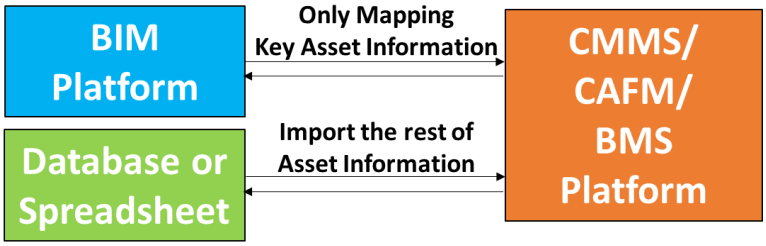

Figure 6 Asset Information Mapping

Building/facility owner should consult their CMMS/CAFM/BMS service providers to determine which approach suit their current solutions.

It is recommended that the BIM platform supports open APIs for the various FM solutions to have bi-directional communication, both for reading data and to write data back. The ability to visualise the 3D/2D graphics served by the BIM platform within the FM applications would be a substantial added benefit to bring the power of BIM into every FM solution.

3. OTHER CONSIDERATIONS

3.1 Asset Information of Existing Buildings

As many existing buildings are not in BIM format yet, building/facility owner may consider the use of 3D laser scanning technology to produce a precise record of the physical space and asset. Traditionally, the data collected could be used as a base to develop the Asset Information Model. With the recent development in the laser technology (e.g. coloured ‘point cloud’ data by collecting ‘point cloud’ and images at the same time), the assets ‘point cloud’ data could be tagged and linked to the existing asset management database. Technical alternatives to laser scanning may be explored such that an efficient and cost effective process is achieved.

3.2 Asset Information Executive

To facilitate the information process throughout the entire asset lifecycle, it is recommended that the building/facility owner consider appointing suitably trained and experienced executive to ensure that information collected from the consultants and contractors at the point of facility handover is timely and accurate. These new roles could be undertaken by existing members of the facility management team, provided that they are suitably trained and experienced to handle the job.

3.3 Collaborative Asset Information Collection

To facilitate collaborative asset information collection, building/facility owner could set up a central BIM data store allowing subsystem suppliers and control companies to directly input data into this system through web-based user interfaces. The entered information would then be validated automatically, thereby allowing corrections to be made on the spot. As a result, commissioning would become a part of construction process by eliminating errors and delays in asset information delivery.

3.4 Simplified O&M Manual

This guide recommends that O&M manuals are submitted as an electronic documents linked to BIM as a minimum requirement. However, referring to a long O&M manual during maintenance procedure is impractical. Also, skill level of maintenance personal could vary and their understanding and interpretation could be different.

Many CMMS software are able to present simplified maintenance guides by means of checklists and simple task lists. This may include a list of maintenance procedures to be carried out at given intervals, steps involved in each maintenance procedure, consumable spare parts and tools involved in each procedure, etc. Some CMMS software would also be able to automatically set up maintenance schedules if the maintenance information is provided in machine-readable format. Building/facility owner could consider requesting this type of simplified maintenance guides instead of a standard O&M manual to be linked to the BIM model.

3.5 Asset Monitoring & Control

It is not uncommon that building/facility owner would like to acquire a system that would be able to monitor and control their assets via a computer system. In order to monitor and control their assets remotely, a set of important parameters (also known as points) would be necessary to be included in the asset information requirements. Building/facility owner should consult their BMS service providers to determine which assets and what are the parameters needed to ensure the information is available when they receive the AIM.

3.6 Enabling Predictive Maintenance

To enable condition-based maintenance (also known as predictive maintenance), it is necessary to establish a baseline for KPIs (key performance indicators) of certain assets. This is often done at the commissioning stage. These KPIs could then be

monitored periodically to find significant deviations, which would suggest upcoming maintenance requirements. Building/facility owner would need to specify that the asset information deliverables should include monitoring and control parameters (as mentioned in previous section) to generate necessary KPIs to monitor the asset's health.

ANNEX A – Organisational Information Requirements (OIR) Example

This annex gives an example of the Organisational Information Requirements (OIR) which is usually defined and used by senior management and decision makers. At this level, the information gathered should support the “Strategic Objectives” of the organisation such as measures of organisation business drivers of safety, performance, environments, etc.

The following statements are examples of organisational information requirements that set out the context and intended use of the information received and processed within an organisation:

- To have access to all property asset (buildings) data in one common data environment
- To understand trend analysis and benchmarking across different project and/or building
- To comply with statutory and regulatory requirements (i.e. Green Building)
- To have access and to track on important property changes (i.e. Lease, End of defects period, etc)
- To maintain and retain asset information for future procurement events
- To have access on metering utility data to identify the energy performance
- To determine the cost of specific activities (i.e. total cost of maintaining specific asset)
- To determine whole life cycle cost of assets

ANNEX B – Asset Information Requirements (AIR) Example

This annex gives an example for the managed asset of a typical commercial building project together with the minimum information required for each asset. Building/facility owners are advised to exercise due judgement in using this Annex and make their own adjustments as needed with their appointed BIM Professionals and real estate management team.

(X) = Required Information

	Designer Input	Contractor/Sub-contractor/Supplier Input													
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Architectural Model																
Room/Space	Finishes (Floor, Wall, Ceiling), Mode of Ventilation, If Accessible, Water Proofing Type															X

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Car Park	Deck number, number of car lots, motorcycle lots, handicap lots, car wash bays, electrical vehicle parking lots, loading and loading bays, structural loading for all decks (e.g. 2.5kN/m2), headroom for all decks, number of car park lifts, areas & location within car park designed for future conversion (i.e. future-ready space)															**X**
Doors (Selected doors)	Fire Rating	**X**	**X**	**X**		**X**			**X**	**X**	**X**	**X**				
Windows (Selected windows)	Fire Rating, Acoustic Rating, U-Value	**X**	**X**	**X**		**X**	**X**		**X**		**X**	**X**				
Roofing Systems	Fire Rating, Water Proofing Type	**X**	**X**	**X**		**X**		**X**	**X**			**X**				

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Furniture Systems (Casework, Cabinets)		X	X	X		X			X	X	X	X				
Conveying Equip. (Lift, Escalators)		X	X	X		X	X		X			X				X
Curtain Wall, Storefront	Fire Rating, U-Value	X	X	X		X			X		X	X				
Fixtures (Plumbing)		X	X	X		X	X		X	X	X	X		X	X	X
ACMV System Model																
Air Terminals (Grilles, Diffusers, Registers)	Design Air Flow	X	X	X		X	X		X	X	X	X				
Duct Accessories (Dampers, Filters, Silencers)	Fire Rating (for Dampers)	X	X	X		X	X		X	X	X	X				
Mechanical Fans	Power Input, Design Air Flow, Static Pressure	X	X	X		X	X	X	X	X	X	X	X	X	X	X

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Air Handling Units	Design Air Flow, Total Cooling Capacity, Sensible Cooling Capacity, Power Input, Static Pressure	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Fan Coil Units	Design Air Flow, Total Cooling Capacity, Sensible Cooling Capacity, Power Input, External Static Pressure	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Cooling Towers	Total Cooling Capacity, Condenser Water Flow Rate, Power Input, Fan Static Pressure	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Chillers	Cooling Capacity, Chilled Water Supply/Return temperature, Chilled Water Flow Rate per Cooling Ton, Condenser Flow Rate per Cooling Ton, Efficiency	X	X	X		X	X	X	X	X	X	X	X	X	X	X

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Water Pumps	Pump Flow Rate, Pump Head, Power Input	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Control Panel		X	X	X		X	X		X	X	X	X				
Heat Recovery Unit		X	X	X		X	X	X	X	X	X	X				
Pipe Accessories (Valves, Meters)		X	X	X		X	X		X	X	X	X				
Variable Air Volume Boxes (VAV)	Air Flow Capacity	X	X	X		X	X	X	X	X	X	X				
Compressor and Condenser Units	Total Cooling Capacity, Power Input	X	X	X		X	X	X	X	X	X	X		X	X	
Plumbing and Sanitary System Model																
Water Tanks, Hydro-pneumatic Tank	Effective Capacity, Tank Material	X	X	X		X	X		X	X	X	X	X	X	X	X

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Water Pumps	Pump Flow Rate, Power Input, Pump Head	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Water Heaters	Effective Capacity, Power Input	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Control Panel		X	X	X		X	X		X	X	X	X				
Pressure Vessel	Effective Capacity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Pipe Accessories (Valves, Meters)		X	X	X		X	X		X	X	X	X				
Floor Waste & Floor Trap		X	X	X		X	X		X	X	X	X				
Bibs and Taps		X	X	X		X	X		X	X	X	X				
Inspection Chamber / Silt Trap	Top Level, Invert Level	X	X	X		X	X		X	X	X	X				

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Waste sumps, Dilution Tanks		X	X	X		X	X		X	X	X	X				
Plumbing Misc. Equipment		X	X	X		X	X	X	X	X	X	X				
Fire Protection System Model																
Sprinklers	Temperature Rating, K factor, Hazard Group	X	X	X		X	X		X	X	X	X		X	X	
Breeching Inlet	Design Pressure, Design Flow Rate	X	X	X		X	X									
Fire Hydrant	Design Pressure, Design Flow Rate	X	X	X		X	X		X	X	X	X		X	X	X
Fire Hose Reel	Design Pressure, Design Flow Rate	X	X	X		X	X	X	X	X	X	X		X	X	X
Fire Sprinkler Pump, Jockey Pump	Pump Flow rate, Pump Head, Power Input	X	X	X		X	X	X	X	X	X	X		X	X	X

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Fire Alarm Panels, Sub Alarm Panels		X	X	X		X	X		X	X	X	X				
Sprinkler Tank	Effective Volume, Effective, Height, Tank Material	X	X	X		X	X		X	X	X	X		X	X	X
Fire Alarm Devices (Fire Alarms, Break Glass Push Button, Heat Detector, Smoke Detector)		X	X	X		X	X		X	X	X	X				
Pipe Accessories (Valves, Meters)		X	X	X		X	X		X	X	X	X				
Electrical and Lighting System Model																
Lighting Fixtures		X	X	X		X	X	X	X	X	X	X				X
Electrical Equipment (DB, Generator, Panels, Control Panels, Transformers, HT Switchgear, LV switchboard)		X	X	X		X	X		X	X	X	X				

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Electrical & Communication Devices and Fixtures (Switches, Speakers, Card Access Readers, Call Panels & Buttons, Isolators, FTP, CCTV, cameras, Data Points, Servers, Socket outlets, AV Projector Screen)		**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**				
Gas Piping System Model																
Gas Pipe Box-up		**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**				
Pipe Accessories (Valves, Meters)		**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**				
Lightning Protection System Model																

	Designer Input	Contractor/Sub-contractor/Supplier Input														
		Type Name	Category	Type Description	Asset Type (Fixed/Moveable)	Manufacturer	Model Number	Expected Life (in months)	Component Name	Storey Number (Level)	Location	Component Description	Serial Number	Installation Date	Warranty End Date	Asset Identifier
Lightning Pit		X	X	X		X	X		X	X	X	X				
Test Link Box		X	X	X		X	X		X	X	X	X				

ANNEX C – Employer's Information Requirements (EIR) Example

This annex gives an example of Employer's Information Requirements (or client's BIM requirements) as an important element of Project BIM implementation that set out clearly to the Project Team what information (models, documents, and data) is required generally and at each project stage. Information collected during previous operation, maintenance and monitoring of the asset.

The following is an example of the core content of the EIR:

A. Management:
   - Applicable Standards/Guides (i.e. Singapore BIM Guide v2)
   - BIM and Asset Information Deliverables
   - Ownership and Rights to Deliverables
   - Collaborative Working (i.e. define how, where and when project information will be shared)
   - Model Authoring and Data Segregation (i.e. to set out requirements for the management of the modelling process)
   - Coordination and Class Detection (i.e. to define coordination process to meet employer's requirements for quality control)
   - Compliance Plan (i.e. to define how to maintain data integrity and quality)
   - Asset Information Delivery Strategy (i.e. to defines the information exchange standard for asset information with regards to asset information delivery into the employer's Asset Management environment)

B. Technical:
   - Information Exchange Format and Software Applications
   - Coordinates (i.e. to define the adoption a common coordinate system for all BIM data)

ANNEX D – Case Study

This annex gives an example of BIM for Healthcare Asset Information Delivery[2] implementation. Figure 7 shows Healthcare Infrastructure Project Division (HIPD) process from defining the Asset Information Requirements (AIR) till delivery of the Asset Information Model.

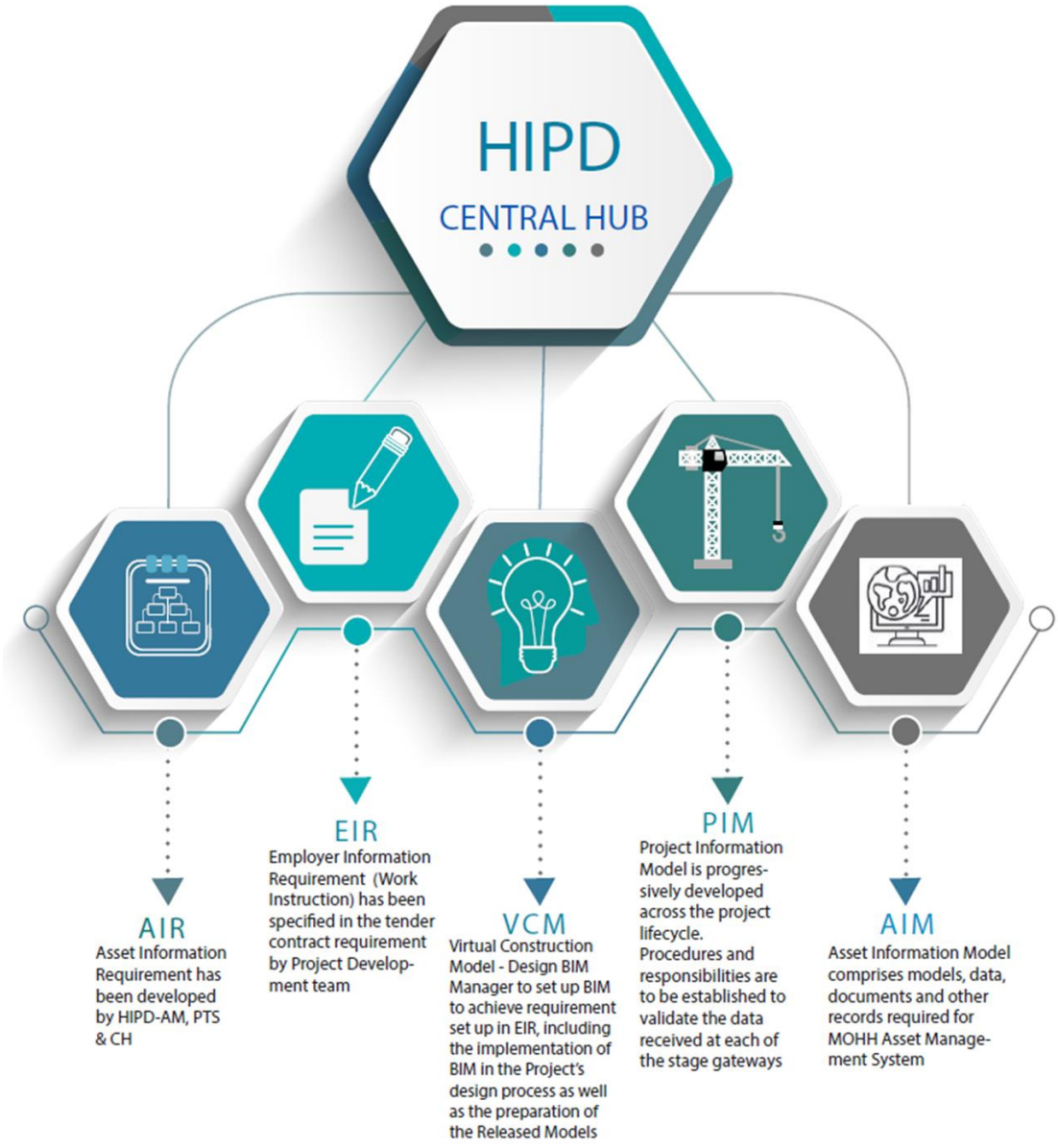

Figure 7 Healthcare Asset Information Delivery Process (PTS = Professional Technical Services, CH = Central Hub)

[2] Courtesy of Ministry of Health Holdings (MOHH)

Figure 8 shows the Healthcare Asset Information Hierarchy from facility to space, infrastructure system, and asset.

Figure 8 Healthcare Asset Information Hierarchy

Several standards and naming conventions are followed in defining the space attributes (see Figure 9), such as:

- TR 42:2015 on Facility Design Guidelines for Acute General Hospitals
- TR 59:2017 on Facility Design Guidelines for Community Hospitals
- Key Planning Unit (KPU)
- Functional Planning Unit (FPU)

Location Code

S/N	Definition	Example	Remarks
1	Site Type	SOC	Type of Facility
2	Facilities Group	NHG	Cluster
3	Facility Name	CHI NCID	Site Name
4	Facility Number	Block A	Block Name
5	Floor Number	L3	Floor /Storey /Level
6	Occupancy Class	Diagnostic and Treatment Areas	KPU
7	Occupant Organizational Groups	Medical Imaging Unit - General	FPU
8	Owner Space Name	X-Ray	Room name / Space Name
9	Space Number	301	Room number (Unique)

Site Type

S/N	Code	Facilities	Remarks
1	GH	General Acute Care Hospital	General hospital
2	SOC	Specialty Center	Cancer /Dental/Heart / Skin /IMH /Medical Center
3	CH	Community Hospital	Community hospital
4	PO	Primary Care Facility	Polyclinics
5	NH	Nursing Facility	NH
6	MP	Master Planning	
7	XF	Other Facilities	Academia, CUP
8	MD	Mixed development project	

Key Planning Unit (KPU)

1. Inpatient Accommodation
2. Outpatient Accommodation
3. Diagnostic and Treatment Area
4. Clinical Support Services
5. General Support Services
6. Operational Support Services
7. Training, Education and Research
8. Administration and Staff Welfare
9. Retail and Amenities Areas
10. Mechanical and Electrical (M&E) Services
11. Inter-departmental Circulation Areas
12. Future Expansion
13. Planters, Terraces & Balconies

Functional Planning Unit (FPU)

3. Diagnostic and Treatment Areas
   - Cardiac Investigation Unit
   - Day Surgery / Procedure Unit
   - Endoscopy Unit
   - Medical Imaging Unit - General
   - Medical Imaging Unit - Nuclear Medicine
   - Operating Unit
   - Radiotherapy Unit - Oncology

Figure 9 Space Attributes

The infrastructure system consists of 12 systems (Figure 10) which comprises of key non-medical (Figure 11) and medical (Figure 12) assets.

S/N	System	Sub-System
01	ACMV System	•MV Systems •Air-conditioning Systems ➢Centralised Cooling Systems ➢ OT and ICU systems
02	Electrical System	•HV Systems •LV Systems •Emergency Power System •Isolation Transformer / Earth Leakage •Lightning Protection
03	Fire fighting System	•EVC System •Sprinkler System •Gas Suppression System •Automatic Detection Systems (Heat and Smoke detectors) •Hose reel System •External Private Hydrant System
04	Plumbing and Sanitary System	Potable and NEWater Distribution System Drainage System Hot water System
05	Extra Low Voltage (ELV) System	•CCTV Systems and Card Access •Security and intruder Alarm Systems •PA / Background Music Systems •Structured Cabling Systems •Carpark management system •Integrated Building Management System •CATV System •IPTV System •Intercom System •VoIP System

S/N	System	Sub-System
06	Gas Distribution System	•Town gas systems •Medical gas systems
07	Automatic Material Conveyance System	•Pneumatic Tube System •Pneumatic Rubbish Chute System •Automatic Guided Vehicle
08	Lift and Escalator System	•Lifts •Escalators
09	Architectural System	•Exterior and landscaping •Interior and finish •Openings, passages and protection
10	Structural System	• Foundation • Envelope enclosure
11	Furniture & Equipment	• Non-medical • Medical F&E
12	Information & Communication Technology System	• Data centre/ Server room • Comm. cabling room • Local area network • Cabling from MDF to data centre

Figure 10 HIPD Infrastructure System

S/N	OmniClass Number	OmniClass Title
1	23-11 27 15	Irrigation Equipment
2	23-11 27 21	Pond Equipment
3	23-17 11 00	Doors
4	23-17 11 35	Fire Shutters
5	23-17 23 21	Evacuation Equipment
6	23-23 11 13	Escalators
7	23-23 13 11	Lifts
8	23-23 17 11	Dumbwaiters
9	23-23 17 13	Material Transport
10	23-23 17 13 13 11	Guided Vehicle Material Handling
11	23-23 17 21	Pneumatic Tube Systems
12	23-23 23 15	Loading Dock Lifts
13	23-27 13 13	Building Control Systems
14	23-27 17 00	Pumps
15	23-27 19 00	Engines
16	23-27 21 00	Compressors
17	23-27 23 00	Heat Exchangers
18	23-27 29 19	Tanks
19	23-27 35 00	Variable Speed Drives
20	23-29 25 00	Fire Fighting Equipment
21	23-29 25 13	Fire Hydrants
22	23-29 25 15	Fire Hose Equipment
23	23-29 25 19	Fire Extinguishers
24	23-29 35 00	Fire Rescue Component
25	23-29 37 00	Occupational Safety and Health Equipment

S/N	OmniClass Number	OmniClass Title
26	23-31 29 00	Hot Water Heaters
27	23-33 17 00	Heat Pumps
28	23-33 21 00	Chillers
29	23-33 23 00	Cooling Towers
30	23-33 25 00	Air Handling Units
31	23-33 27 13	Dehumidifiers
32	23-33 29 00	HVAC Dampers
33	23-33 31 11	Air Curtains
34	23-33 31 19	Fans
35	23-33 33 11	Fan Coil Units
36	23-33 39 11	Air Conditioners
37	23-33 41 00	HVAC Air Terminals
38	23-33 41 19	Exhaust Terminals
39	23-33 43 00	HVAC Condenser Units
40	23-35 11 00	Electrical Generators
41	23-35 13 00	Transformers
42	23-35 15 00	Electric Motors
43	23-35 17 00	Variable Speed Drives
44	23-35 23 21	Uninterrupted Power Supply (UPS) Units
45	23-35 47 11	Lighting Fixtures
46	23-37 00 00	Information and Communication Specific Products and Equipment
47	23-37 15 00	Audio Visual Equipment
48	23-39 45 21	Solid Waste Treatment Equipment

Figure 11 Key Equipment (Non-Medical)

S/N	OmniClass Number	OmniClass Title
1	23-25 13 11	Audiology Equipment
2	23-25 15 13	Autopsy and Postmortem Equipment
3	23-25 17 13	Dental Equipment
4	23-25 19 13	Dermatology Equipment
5	23-25 21 13	Emergency Trauma and Intensive Equipment
6	23-25 23 13	Endocrinology Equipment
7	23-25 25 13	Gastroenterology Equipment
8	23-25 27 13	General Internal Medicine Equipment
9	23-25 29 13	Therapeutic and Physical Therapy Equipment
10	23-25 31 13	Hematology Equipment
11	23-25 33 21	Medical Gas Filtering Equipment
12	23-25 33 31	Medical Gas Treatment Equipment
13	23-25 35 13	Nursing Equipment
14	23-25 37 13	Obstetrics and Gynecology Equipment
15	23-25 39 13	Ophthalmology Equipment
16	23-25 41 13	Orthopedics Equipment
17	23-25 43 13	Otolaryngology Equipment
18	23-25 45 13	Patient Care Equipment
19	23-25 47 13	Patient Clinical Diagnostic Equipment
20	23-25 49 00	Patient Transportation and Lifting Equipment
21	23-25 51 13	Pediatrics Equipment
22	23-25 53 13	Pharmacology Equipment
23	23-25 57 11	Sterilizer Equipment
24	23-25 59 13	Surgical Equipment
25	23-25 63 13	X Ray and Imagery Equipment
26	23-25 63 17	Specialized Medical Computer Equipment
27	23-25 69 13	Laboratory And Scientific Equipment

Figure 12 Key Equipment (Medical)

For each asset, all 22 attributes (see Figure 13) are required to be incorporated into the Asset Information Model.

S/N	System
1	Asset Name
2	Description
3	Physically Installed On
4	Area Served
5	Type of Asset (OmniClass Table 23, 2012-05-16)
6	System
7	Model No.
8	Brand
9	Serial No.
10	Price At Ownership (S$) (Unit Cost + Installation Cost)
11	Life Span (Years)

S/N	System
12	Warranty End Date
13	Equipment Manufacturer
14	Installer
15	Name of Supplier
16	License Number (Product Certification)
17	License Description
18	License Type
19	Valid From (DD / MM / YYYY)
20	Valid To (DD / MM / YYYY)
21	Data Provided By (Email)
22	Data Provided Date (DD / MM / YYYY)

Figure 13 Asset Attributes

References

PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling. BSI Standards.

PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information modelling. BSI Standards.

BS 1192-4:2014 Collaborative production of information Part 4: Fulfilling employer's information exchange requirements using COBie – Code of practice. BSI Standards.

PAS 1192-5:2015 Specification for security-minded building information modelling, digital built environments and smart asset management. BSI Standards.

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STD/BIM/P005 (G0200) Employer's Information Requirements (EIR) of UK Ministry of Justice

Form DES-0002-D: BIM Asset Data for Design and As-Built Documentation for New Construction and Renovation, Los Angeles Community College District

Singapore BIM Guide Version 2

Asset Information Guidelines, The Institute of Asset Management 2009

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www.bca.gov.sg

For more information and feedback on the BIM Guide for Asset Information Delivery, please visit the CORENET website: *www.corenet.gov.sg*