# Essential Guidance for Scan to BIM for Digital Twins with Autodesk Tandem

AUTODESK

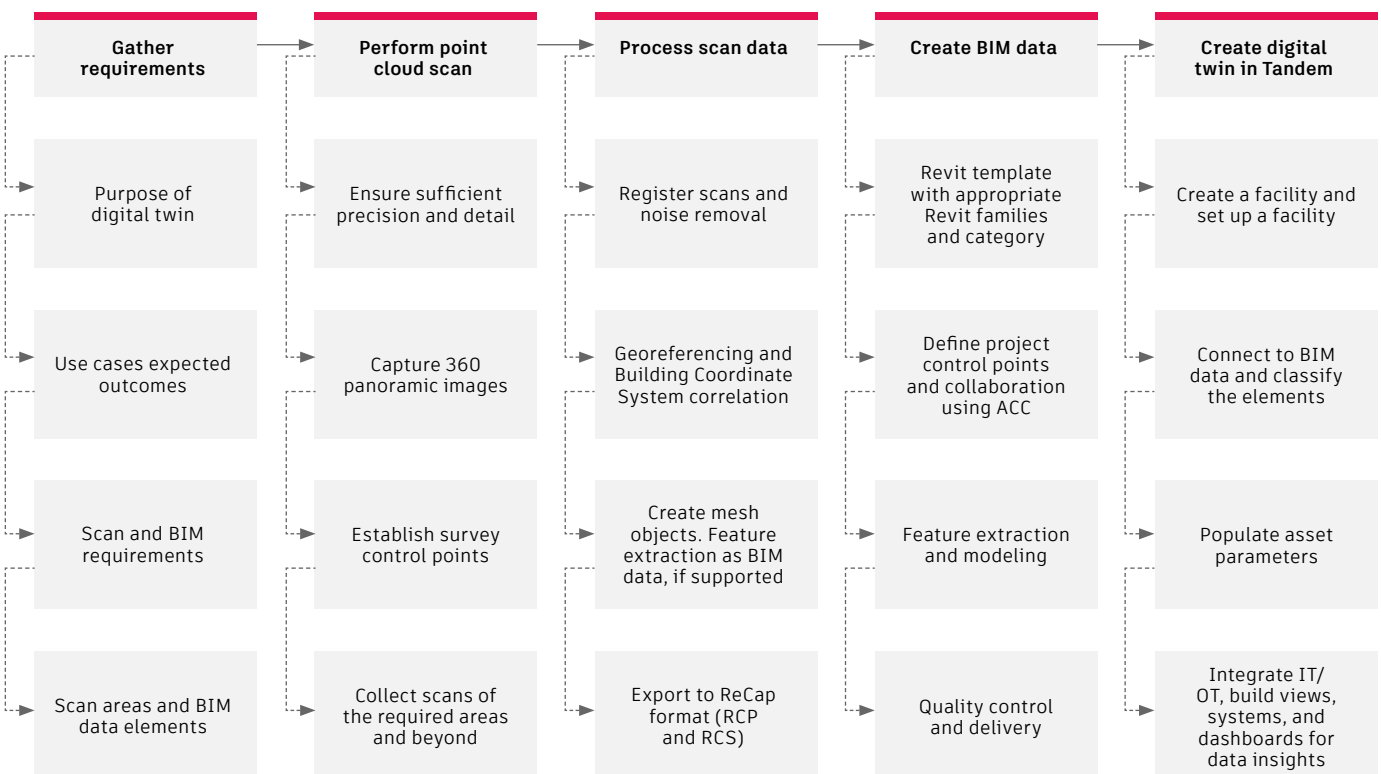
# Introduction

This document provides general guidance on scanning and creating a Building Information Model (BIM) for use with Autodesk Tandem. The guidance covers various aspects of the process, including the level of detail required, elemental breakdown, and considerations for project-specific elements.

Please note that the information provided here is intended as guidance only.

Users should perform their due diligence and conduct their own needs assessments to ensure the applicability and effectiveness of the guidance for their specific projects.

The following image illustrates the typical steps and their details involved in the scan-to-BIM activity, as well as the high-level processes required to create a descriptive digital twin.



# To scan or not to scan...

Autodesk Tandem has adopted a BIM-first approach towards digital twins, recognizing that the most realistic digital replicas are 3D models. In the realm of architecture, engineering, construction, and operation (AECO), digital twins that utilize BIM data offer unparalleled precision and detail. While new constructions often come with their own BIM data, older structures generally lack this modern asset.

There are two primary methods to create BIM data for an existing structure: from existing plans or through point cloud scans. The first method, known as “Plan-to-BIM”, relies on the existence of current and accurate building plans, which can then be used to construct the BIM model using authoring software like Revit. Although there is ongoing innovation aimed at automating this process, it remains an evolving field. The real challenge, however, arises when these drawings are either outdated, incomplete, or unsuitable for the intended digital twin applications. The older the building, the less likely it is to have such detailed and accurate plans.

The other option is conducting a detailed scan of the facility and then creating BIM data from the resulting point cloud. This method, called scan to BIM, ensures that every detail of the structure is captured precisely, forming a solid base for developing an accurate BIM model. These scans serve as a digital mirror of the physical asset, offering a detailed and precise basis for creating the digital twin.

Therefore, when in doubt about the existing plans for the facility, scanning is the best option. Despite the extra cost, scanning offers the most precise data for creating a digital twin. Scan to BIM is advancing with many innovations in automation. Though some tools provide partial automation now, it’s likely that within a few years, the process will become mostly automated, reducing the cost and time needed to create the geometric aspects of BIM data from point cloud scans.

# Key points to consider when specifying a 3D point cloud

When undertaking a project to create a Building Information Model (BIM) from a point cloud, several critical factors must be considered to ensure the suitability, accuracy, and reliability of the BIM data for the digital twin. The following points outline essential specifications and guidelines for attaining a comprehensive 3D point cloud scan:

1 These point clouds must consist of detailed and accurate data points in an X-Y-Z coordinate system with the approved/agreed survey control points.

2 Survey control points must be coordinated and approved before laser scanning begins. Generally, three to seven points are needed for geolocation and should be distributed throughout the facility.

3 The point cloud data should be collected using laser scanning equipment. The specific equipment and sufficient number of scanning positions must be clearly described in the Technical Proposal.

4 Besides point clouds, it's advised to capture 360 panoramic images at all key areas in the facility. Most modern scanning devices can take these images during the scan, and they should include geolocations.

5 The following are typical specifications for point cloud survey. It is worth noting that while these specifications provide a good starting point, the level of accuracy may not always need to be so stringent. Depending on the specific requirements of the project, there can be some tolerance in these values. Essentially, as the values increase, the accuracy and density of point cloud data will decrease. Therefore, it is advisable to negotiate the precision based on the project's requirements.

- Point density: ≤0.5 cm
- Range accuracy: ≤0.5 cm
- Point cloud accuracy: < 2 mm
- Overall 3D positional accuracy: ≤ 7 mm
- Colorization: RGB color and grey-scaled intensity with real view photos

6 While 3D laser Scanning typically refers to stationary, terrestrial based LiDAR, mobile LiDAR systems offer advantages in speed with some disadvantages in accuracy. Consult with your reality capture solutions provider to determine the proper technology to use depending on your projects technical specifications.

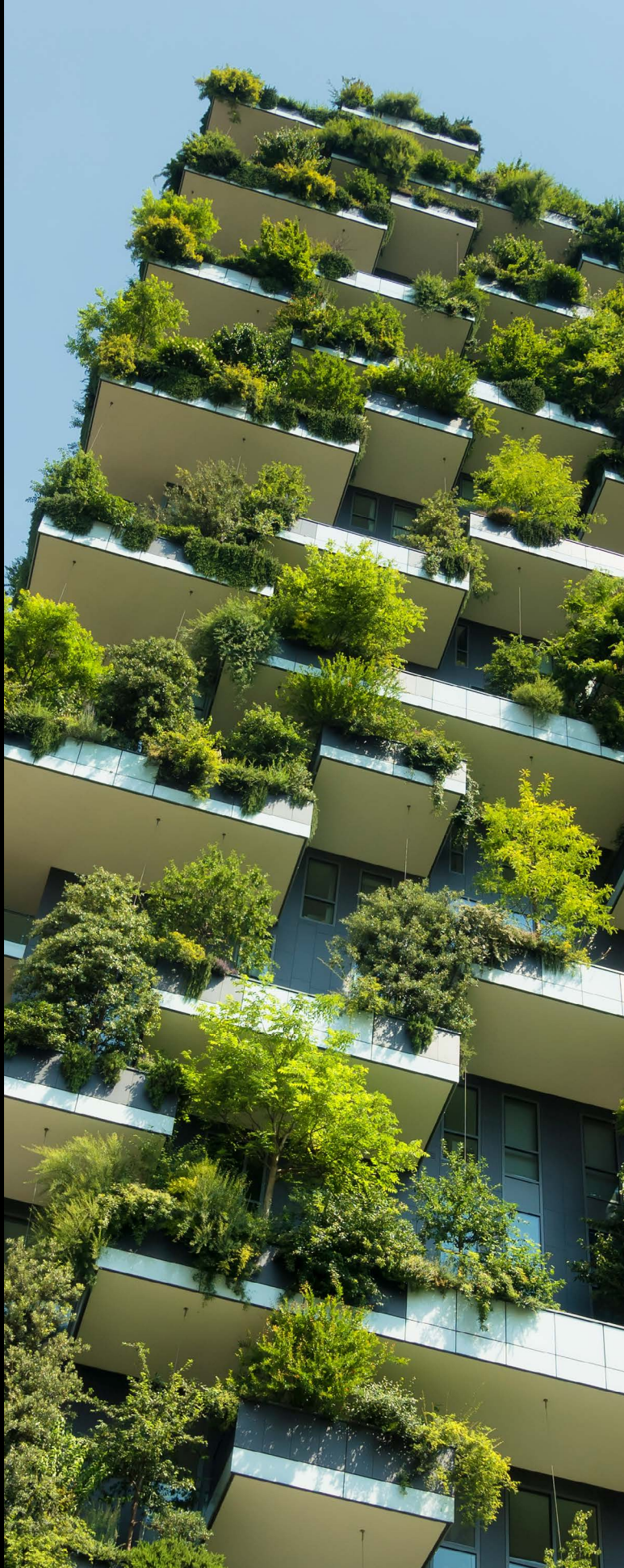
7 It's wise to scan the entire facility, even if you don't need the data right away. This information can later be used to create BIM data for digital twins. Otherwise, you'll have to revisit the site to rescan, which is costly and time-consuming. Focus on permanent assets and fixtures, as they are less likely to change. Doing this all at once saves time and money.

8 While scanning, make sure asset tags or names are clearly visible to add this information to BIM data.

9 Ask for proof of evidence as to the final accuracy of the deliverables, including measurements, calculations, equipment quantity, and specifications.

10 The point cloud data should be converted to .rcs point cloud files and aggregated into one or more Point Cloud Projects (.rcp files) with ReCap software for easy creation of BIM data.

11 Request mesh files if they are an available option. Mesh files can be loaded directly into Revit and integrated with Revit elements. This reduces the effort needed to create a BIM model, as not all elements need to be Revit elements. Some elements, especially those used primarily for background or visual context purposes, can be replaced with mesh objects, thus saving cost and time.



# Key points to consider for developing a BIM model from scan data

Most of the use cases for scan-to-BIM are for renovation or expansion projects, primarily for construction purposes. However, in our case, the main reason for using the BIM model is to create a digital twin to manage, monitor, and maintain the facility rather than for construction purposes. Much of the guidance below relates to this particular need.

## 01 Model completeness

Do we have a complete (fit for purpose) representation of the facility in the models? It could include multiple models as long as they represent the facility with all the elements relevant/required for the twin.

a. Ensure that the model contains elements representing assets, systems, and spaces, as necessary to meet the objectives of the digital twin.

b. Check if there are any data gaps in the model.

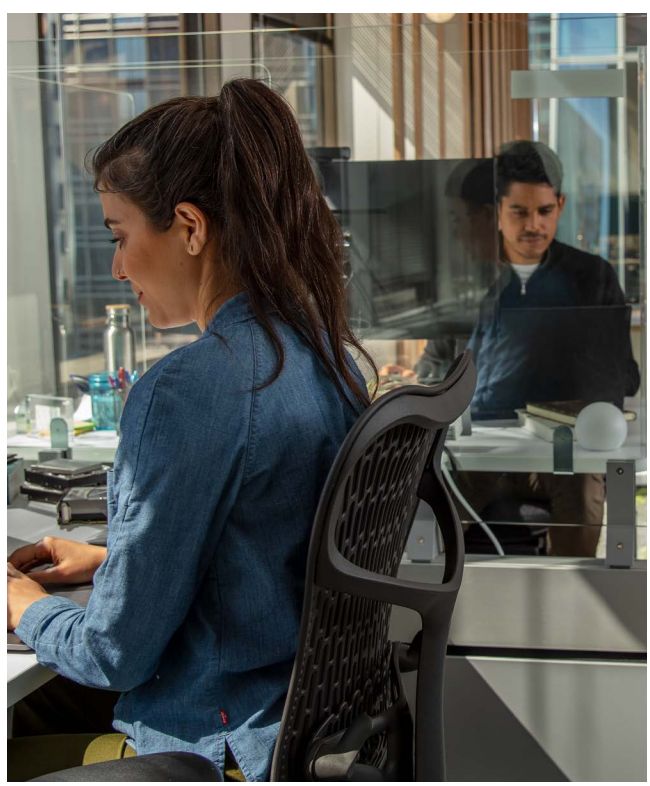
## 02 Model naming convention

A facility would typically consist of multiple models from different disciplines, quite often from different sub-contractors. This could lead to inconsistent naming conventions for the BIM data. For efficient use of digital twin, it is imperative that we have standard naming conventions for rooms, spaces, floors, and other model elements across all the models. It would be prudent to ensure the naming conventions align with the naming conventions applied to other systems used in the facility such as BMS, CAFM, CMMS etc.

a. Consistently follow standard naming conventions for assets, levels, and spaces/ rooms during modeling in Revit to simplify querying and filtering, reduce additional efforts in Autodesk Tandem, and ensure effective collaboration across multiple authors and files.

b. Check if elements spanning multiple levels (stairs, elevator shafts, curtain walls) are correctly associated with levels.

c. Ensure all elements are associated to appropriate levels.



## 03 Level of detail, association, and location

The models should possess sufficient granularity to accurately represent all assets at the appropriate level of detail required by the digital twin. The following points should be considered to ensure this is achieved:

a. Check if the model elements represent the assets at the appropriate level of detail.

b. Try to model the whole asset, instead of splitting into multiple elements. For example, for facility management and operation, it is more convenient if the door is modeled as one element that includes door frames, doors, handles, door panels etc. From BIM for Construction perspective, these would be captured as separate elements to facilitate construction and installation. However, that level of granularity is not required when modeling for Facilities Management.

c. Check if all the assets represented in the model are at the correct location in relation to the facility.

d. Ensure there is no duplication of objects if using multiple models to avoid skewed analysis and increased costs.

e. Assign textures and colors that closely match the actual physical assets. Digital twins are visual tools, and a closer resemblance enhances user acceptance and association.

f. Model element association with Rooms/Analytical Spaces—the model elements representing assets should be placed in the correct rooms/spaces and levels. Tandem establishes room associations upon import. Ensure that model elements representing assets are accurately positioned in the 3D space to facilitate their correct automatic association when imported into Tandem.

g. Verify that all rooms and spaces are correctly named.

## 04 Model element properties

The model elements will contain some basic Revit properties. While it is not required that they contain all the asset maintenance information properties, they need to contain asset identification information at a minimum. This could be the asset name or asset tag that uniquely identifies the asset. Any additional asset information can be added directly in Tandem or imported from other sources such as MS Excel, CAFM/CMMS systems. Additionally, they will include basic or default Revit parameter details generated during BIM data creation. Check for the following:

a. Do the model elements contain asset identification information? Note: With Autodesk Tandem Dashboards, you can easily verify the presence of values in parameters. However, you'll still need to confirm the accuracy of these values.

b. "Asset Tag" should be recorded as Revit Element property (not a Type property).

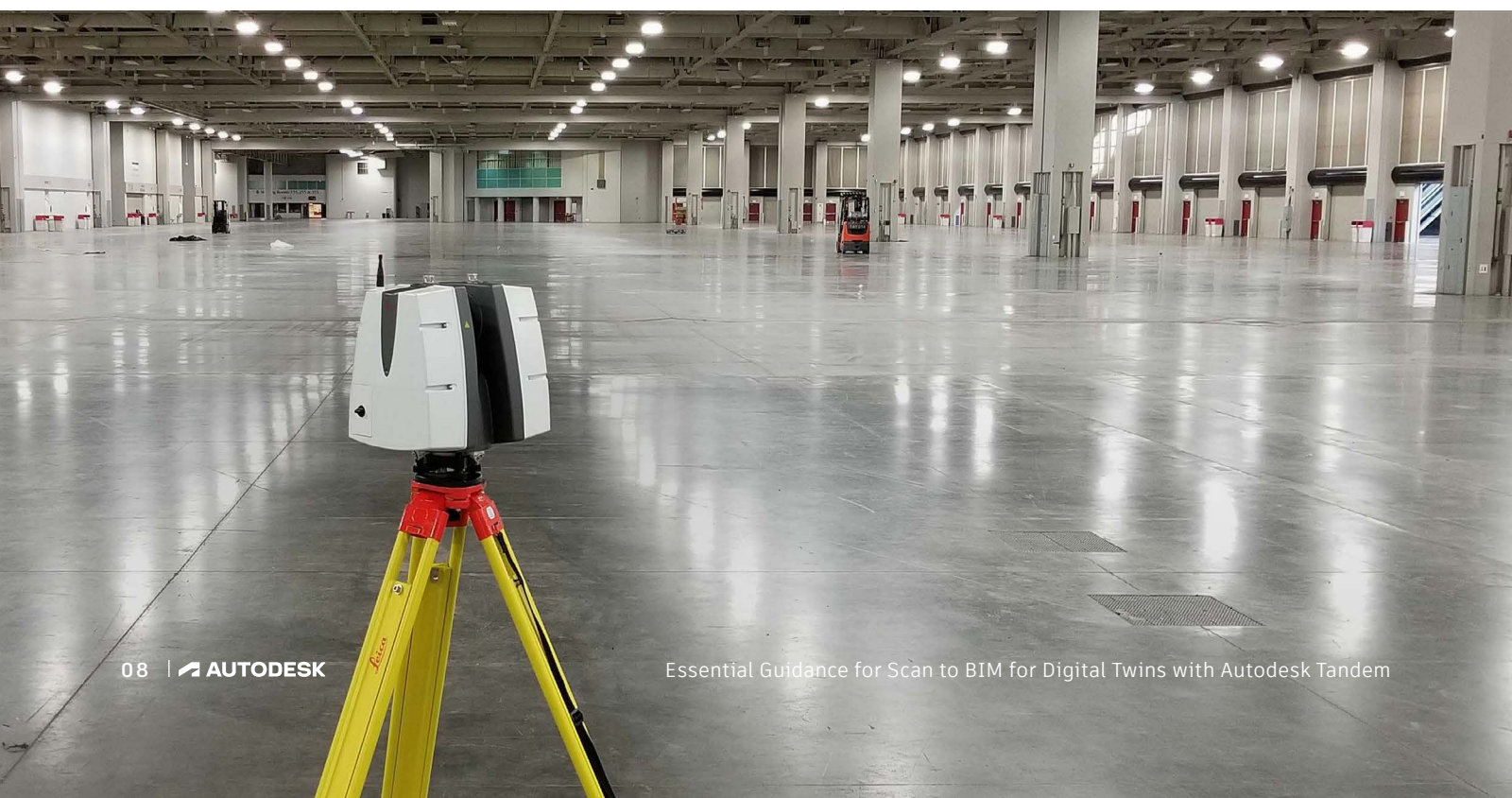
c. Avoid using generic elements when modeling elements in Revit. Every element should belong to a specific category and Type. While modeling, work with the BIM team to offer guidance on categorizing assets when needed.

## 05 Geolocation and model alignment

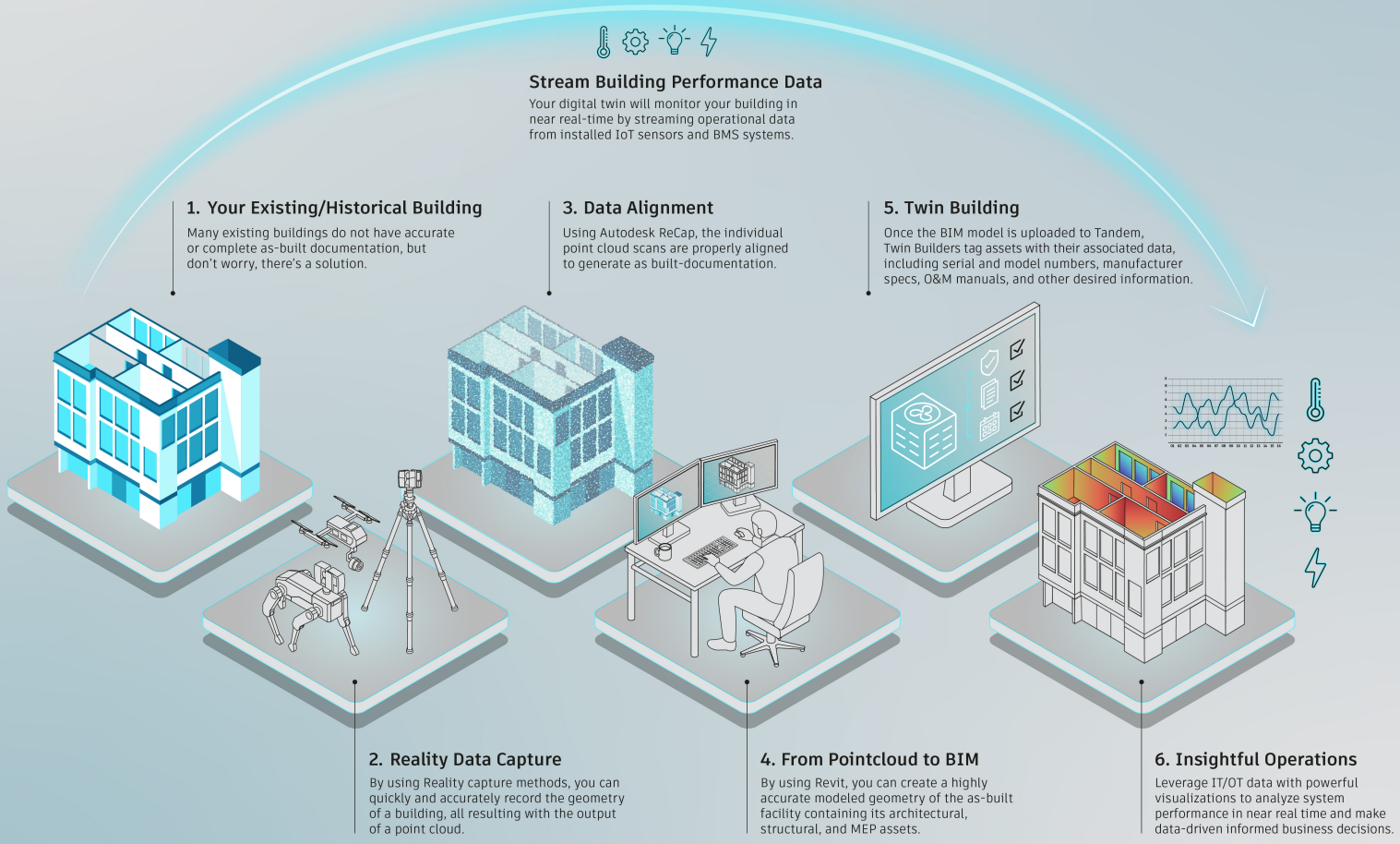
The Facility models should be correctly geolocated. If using Revit:

a. Establish primary survey control point to provide an accurate geolocation for the project. This should be based on the National coordinate system.

b. Define a project base point to link the model to a recognized project coordinate system.



## The Scan to BIM to Digital Twin Process




# Common elements to include in a BIM model

A model can be created at various Levels of Detail (LOD) to ensure efficiency and reduce cost, prevent over-modeling, to deliver the best results. For example, the external façade may require LOD400, but the building interior may only require LOD300.

### Elemental breakdown

Below is an elemental breakdown designed to cover the most common elements, however, it is a non-exhaustive list and as such further requirements may be specified. During negotiations about generating BIM data from scan data, the LOD for each element must be agreed upon, since pricing usually depends on the LOD. These LOD values generally range from 100 to 500. The modeling guidance can be adjusted based on the facility's needs and intended use. Comments are for general understanding of the relevance of the data for digital twins.

| Element category | Element | Modeling guidance | Comments |
|---|---|---|---|
| Building elements | | | BIM data with building elements is usually a basic requirement for Tandem and is generally classified as LOD 200 to LOD 300, requiring minimal effort. This level of BIM data is useful for applications like space utilization monitoring, energy tracking, and indoor climate monitoring by adding sensor or device locations to BIM data. |
| | External walls/ curtain walls | | |
| | Roof coverings | | |
| | Clear openings | Capture them as spaces. | |
| | Stairs/ramps | Stairs/ramps should be in their own levels. | |
| | Stair/ramp handrails and balustrades | Don't need handrail patterns but need to know a handrail is there. So, it can be modeled as simple element. | |
| | External doors/ shutters | As a single unit (frames & panels & windows). ATTRIBUTES: Door number where it is visible. | |
| | External windows | As a single unit (frames & panels & windows). | |
| | Roof lights and skylights | | |
| | Internal walls/ curtain walls | | |
| | Internal doors | As a single unit (frames & panels & windows). | |
| | Internal windows | As a single unit (frames & panels & windows). | |
| | Lifts and escalators | | |
| | Ceilings | | |

| Element category | Element | Modeling guidance | Comments |
|---|---|---|---|
| Building elements (cont.) | Platforms, decking and balconies | | BIM data with building elements is usually a basic requirement for Tandem and is generally classified as LOD 200 to LOD 300, requiring minimal effort. This level of BIM data is useful for applications like space utilization monitoring, energy tracking, and indoor climate monitoring by adding sensor or device locations to BIM data. |
| | Handrails and balustrades | | |
| | Ladders/slides | | |
| | Architectural embellishments | | |
| | Louvres | | |
| | External soffits | | |
| | Guttering and rainwater pipes | Scan should identify holes & debris / blockages in the gutters. | |
| | Rooms | In addition to the above, create rooms in Revit. Common spaces such as reception areas, lounges should also be captured as rooms in Revit. These are required for spatial trend analysis in Tandem. | |

| Element category | Element | Modeling guidance | Comments |
|---|---|---|---|
| Assets | Furniture | Desks, chairs, desk dividers. Desk numbers & desk QR codes to be recorded where available. Generic chairs & desks can be used (rather than modeled). | The aim is to model managed assets as BIM data, usually using simple or generic shapes.<br>You could consider the following in order to determine the priority of modeling the managed assets:<br>1. Which assets do we need immediately for our use case?<br>2. Which assets consume the largest portion of the maintenance budget?<br>3. The failure of which assets would significantly impact facility operations?<br>4. Which assets frequently fail and require regular monitoring?<br>5. Which assets are the most expensive?<br>Include unique IDs or tags as a single identifying parameter. Additional parameters can be directly added in Autodesk Tandem. While it is possible to add additional parameters in Revit, quite often it is more expensive than adding them directly in Tandem. Autodesk Tandem offers various ways to add parameter data: importing from MS Excel, connecting directly to an external source via API or Tandem Connect, or manually inputting information and attaching or linking documents, images, videos, etc.<br>Each asset type requires its own category in Revit. This type of data is typically captured at LOD 300, 350, or 400. Assets can be added gradually based on digital twin needs. Autodesk Tandem enables incremental updates through Autodesk Docs for BIM data management. |
| | Fixtures / Finishes | | |
| | Fire Safety Equipment | | |
| | ICT Equipment | | |
| | Exhibits | | |
| | Safety Equipment | | |
| | Appliances | | |
| | Audio/Visual | Include large screens, audio video equipment. | |
| | Electrical Equipment | Such as panels, meters, sub meters. | |
| | HVAC Equipment | Such as AHUs, air terminals. | |
| | Lighting Equipment | Lights. | |
| | Meters | Water meters, energy meters. | |
| | Motors | | |
| | Pumps | | |
| | Security equipment | | |
| | Kitchen fittings and equipment | | |
| | Sculptures/statues | | |
| | Major signs | | |

| Element category | Element | Modeling guidance | Comments |
|---|---|---|---|
| Lighting (excl. wiring) | | Should be captured as part of electrical system. | |
| Fire systems (excl. wiring) | | Control panels and sensors. These should be captured as part of fire system. | |
| Facility Surroundings or External Works | | | |
| | Landform (topo surface only) | | |
| | Roads, paths, and hard surfacing | Including car parking locations & EV charging points. | |
| | Step/ramp railings | | |
| | Manholes | | |
| | External shelters/ canopies/stores | Aircon units / condensers. Bike shed & smoking shelters. | |
| | Platforms and decking | | |
| | Grass/earth (topo surface only) | | |
| | Planting | Basic generic models tree / bush locations. | |
| | Trees | | |
| | Fencing/railings | | |
| | Walls/screens | | |
| | Fixed street furniture (lamp post, bollard) | E.g., EV charging points. | |
| | Signage and posts | | |
| | Sculptures/statues | | |
| | Road markings | Show car parking spaces within facility grounds. | |

| Element category | Element | Modeling guidance | Comments |
|---|---|---|---|
| Services/ Systems | | | These are usually captured using Revit MEP and include assets and their connectivity across systems like Hydronic, electrical, and sanitary. They should be recorded as Revit System classes with correct connections and flow direction. Autodesk Tandem can check these using the Systems feature and can be used to fix any missing connections or add missing assets. You can create Systems in Tandem using data from various System classes.<br><br>This data is generally captured at LOD 400 and above, primarily used in Autodesk Tandem for tasks like system trace and analysis, such as finding the panel connected to a switch, identifying the impact area if a valve is turned off, or locating the AHU unit serving an air terminal etc. |
| Sanitary installations | | Should be captured as part of sanitary system class. | |
| Major plant and equipment (e.g. HVAC) | | Should be captured as part of heating/cooling system class. | |
| Major roof plant and equipment | | Should be captured a part of relevant system class. | |
| Services equipment (e.g. radiators) | | | |
| Grilles and exhausts | | | |
| Pipework | | | |
| Ductwork | | | |
| Roof drainage | | | |
| Conveyors | | | |
| Electrical boxes (excl. wiring) | | Should be captured as part of electrical system – panels / fuse boards plus capture any identifying label. | |
| Cable trays (+100mm width, excl. wiring) | | Should be captured as part of electrical or telecom system. | |

| Element category | Element | Modeling guidance | Comments |
|---|---|---|---|
| Sensors | | | For these, we do not need a detailed model of sensor, just basic representation is sufficient as a separate family element for each type of sensor. Please capture unique ID, where visible as family text parameter. This section lists some typical sensors used in buildings. |
| | Occupancy and climate control Sensors | Unique ID, where visible. | |
| | Smoke detectors | | |
| | Sprinklers | | |
| | Gas sensor | | |
| | Sound level detectors | | |
| | Badge readers for door entry | | |
| | Fire Alarm Manual Call Points | | |
| | Security cameras | | |

# Facility specific / non-standard elements / features

These are assets and equipment specific to the facility. For instance, a hospital might possess various medical assets and equipment that require management and are specific to the hospital. These should be captured separately using a table format such as one shown below.

| Element category | Element | Modeling guidance |
|---|---|---|
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# Modeling guidelines and level of information requirements

The level of information refers to the details associated with BIM elements, also known as element parameters. For existing facilities, it is likely that managed asset information is already available, often stored in spreadsheets or asset maintenance systems. We can seamlessly import this data into Tandem using Excel or Tandem Connect/API solutions, avoiding the need for costly manual entry into Revit.

Recognizing the effort and the cost, it's recommended to only capture the unique asset ID or tag as an element parameter in Revit. The rest of the information can be added or imported into Tandem from external sources. This approach is more efficient and accessible, as it eliminates the need for a dedicated BIM specialist. Anyone with access to the Tandem facility can manage this task, ensuring information is up to date without incurring unnecessary expenses.

At a later date, if there is a need to populate the Revit BIM model with this parameter information, it is possible to push the data back from Tandem to Revit once these parameters are defined in Revit. This method ensures that all relevant details are integrated seamlessly, enhancing the efficiency and accuracy of asset management.

If you are new to asset management and looking for some guidance on the type of asset parameters you should consider, for facilities management, space management etc., you can refer to the UK Government Property Data Standard for some examples and guidance.

**Recognizing the effort and the cost, it's recommended to only capture the unique asset ID or tag as an element parameter in Revit. The rest of the information can be added or imported into Tandem from external sources.**

# List of deliverables

**The following represent a typical list of deliverables from a scan to BIM project:**

- Scanning data in its original source format.
- Processed scanning data, ideally in RCS, RCP formats.
- Mesh files.
- Online/offline access to 360-degree panoramic images for identified Points of Interest.
- Revit models in version 20xx or a more recent version.

# Questions worth asking

**Some questions worth asking your scan to BIM service provider:**

- What scanning methods and equipment will you use, and how do they impact accuracy and coverage?
- How do you handle alignment and registration of point clouds, especially for large or complex sites?
- What process do you follow to convert point cloud data into BIM models, and how do you ensure model accuracy against the scans?
- Could you detail your quality-checking procedures?
- Who holds the IP rights for the scanned data, 360-degree images, mesh files, and BIM data?

# Create Tandem digital twin

Ideally, BIM data should be shared via Autodesk Docs, ensuring Tandem is automatically updated with any changes to the BIM data.

### In Tandem you can

1. Create the facility.
2. Based on the digital purpose and requirements, define classification, parameters, and facility template.
3. Classify BIM data into assets using the facility template.
4. Using filters create Views for different use cases or personas. Use filters and Views to visualize the data based on various parameters and draw data-driven insights.
5. Create dashboards for data presence in the parameters.
6. If the BIM data contains system classes, create systems in Tandem for System tracing analysis.
7. Configure property cards to display relevant parameter information.

Upon completing the steps outlined, you will have successfully created a descriptive digital twin in Tandem. To further enhance this setup, you can elevate it to an informative digital twin by connecting and configuring stream connections. This allows you to harness the full potential of digital twins by establishing a connection with the physical facility through sensors, Building Management Systems (BMS), and IoT devices and realize the benefits such as:

- Near Real-time Monitoring: Enable near real-time monitoring of the facility, providing up-to-date insights into its performance.
- Data-Driven Insights: Leverage various data parameters to drive informed decisions and enhance operational efficiency.
- Performance Benchmarking: Measure and benchmark the facility's performance against predefined standards, ensuring optimal functionality.
- Enhanced Reporting: Generate comprehensive reports on the facility's performance, aiding in maintenance and improvement strategies.

By integrating these advanced capabilities, you can greatly improve the management and operation of your facility, making it more efficient and effective, and delivering greater value.