



►► Under the patronage of **H.E. Dr. Abdullah Belhaif Al Nuaimi** - Minister of Infrastructure Development



►► 17th Edition

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Le Meridien Dubai Hotel
& Conference Centre
United Arab Emirates

Under the Theme:
**Enhancing Maintenance
Through Big Data Management**

►► MANAGING DATA OF EXISTING BUILDING FACILITIES USING 3D LASER SCANNING

Prof. Mohamed Marzouk
Cairo University, Egypt





►► Agenda

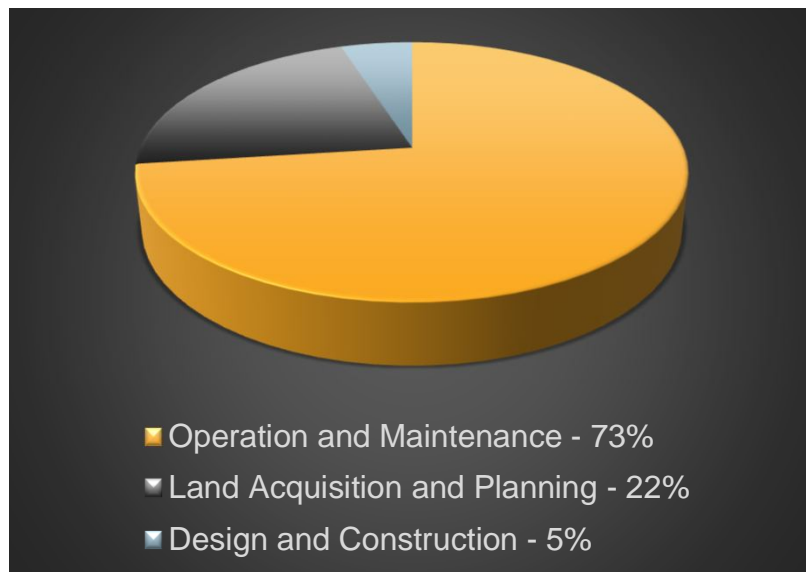
- INTRODUCTION
- CETL ACTIVITIES
- PROPOSED FRAMEWORK
- CONCLUSIONS



►► INTRODUCTION

- Buildings constitute a **key asset** in the urban infrastructure (e.g. hospitals, commercial building, administrative buildings, heritage buildings).
- Buildings facilities must be retained to **Guarantee profitable service delivery.**
- Building facilities Operational and Maintenance (O&M) phase signifies **60 % of the overall lifecycle cost (i.e., greater than the capital expenses).**

►► INTRODUCTION



LIFE CYCLE COST ALLOCATION

Breakdown of building life cycle costs

Golabchi et al. 2013

INTRODUCTION TO BUILDING FACILITIES

- Significant practices occurred during O&M phase are concerned with **the facility's maintenance and repair (M&R) process**.
- The inability to maintain the building facilities at O&M phase leads to **excessive expenditure and inefficient budget allocation**.



►► GENERIC INTRODUCTION

FACILITIES MANAGEMENT COMING INTO SIGHT

- Arise of Building Information Modelling (BIM) facilitates data retrieving during the project life cycle to upgrade the performance of FM activities.
- As such, there is a need to enhance of information transaction to the FM procedure.

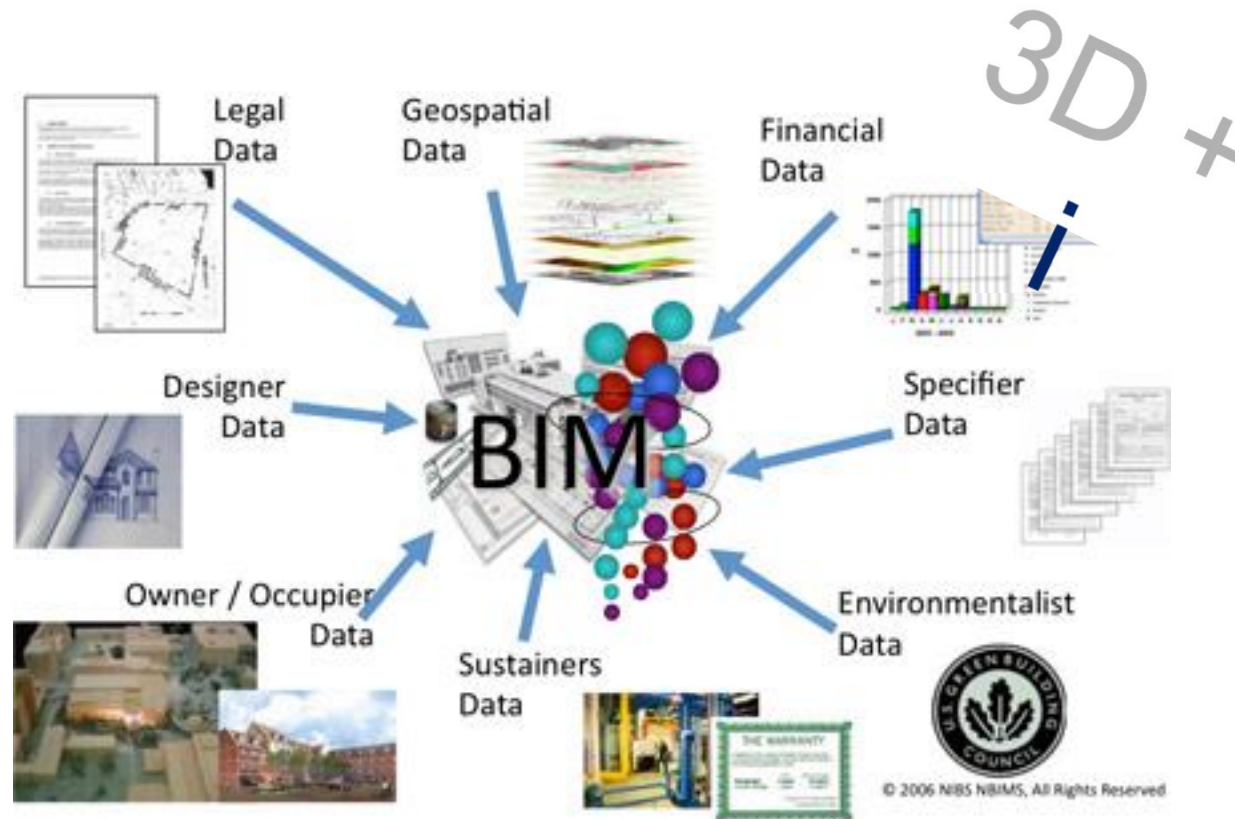
BIM: An Overview



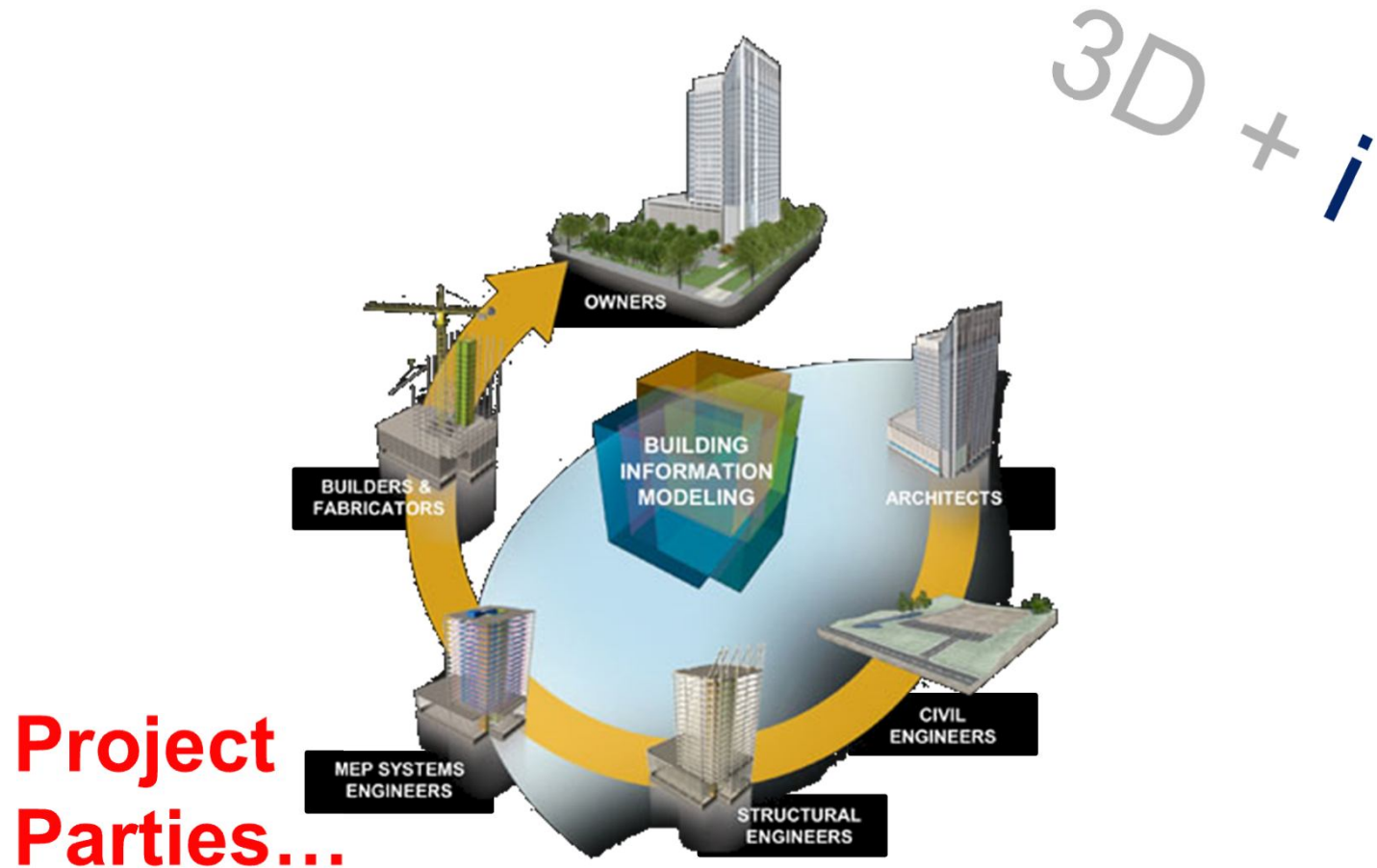
Building information modeling (BIM)

- Approach for efficient coordinated design, construction, and facilities management.
- **Digital representation** of the building
- Facilitate the exchange and interoperability of information in digital format.
- Working in a fully collaborative three dimensions (3D) environment on a shared platform
- From planning phase towards designing, constructing, operating, maintaining, and even demolition.
- Facilitates incorporating physical and functional characteristics within a confined model.
- Cost effectiveness and error omitting, life cycle improvement, quality of the design through massively visualization allowing early mature decisions, reduced field changes

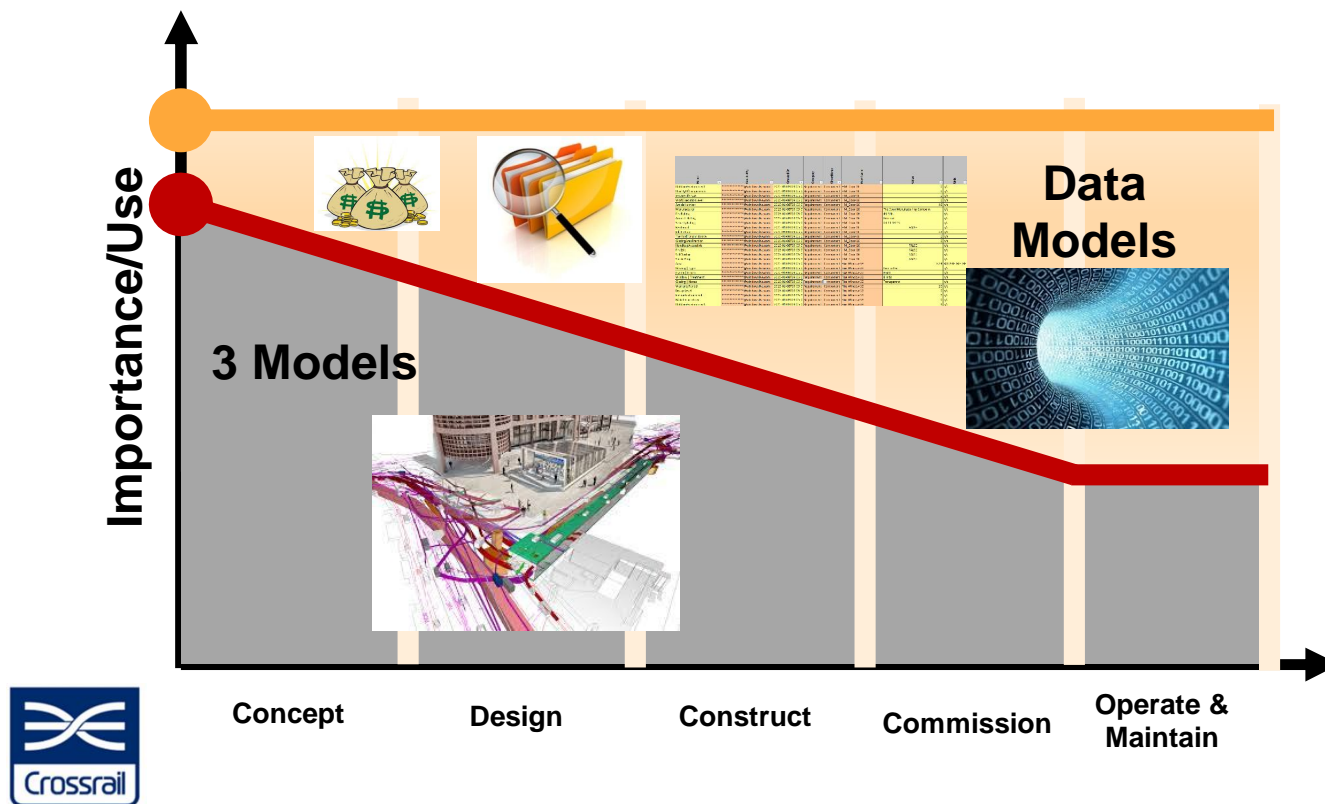
BIM: An Overview



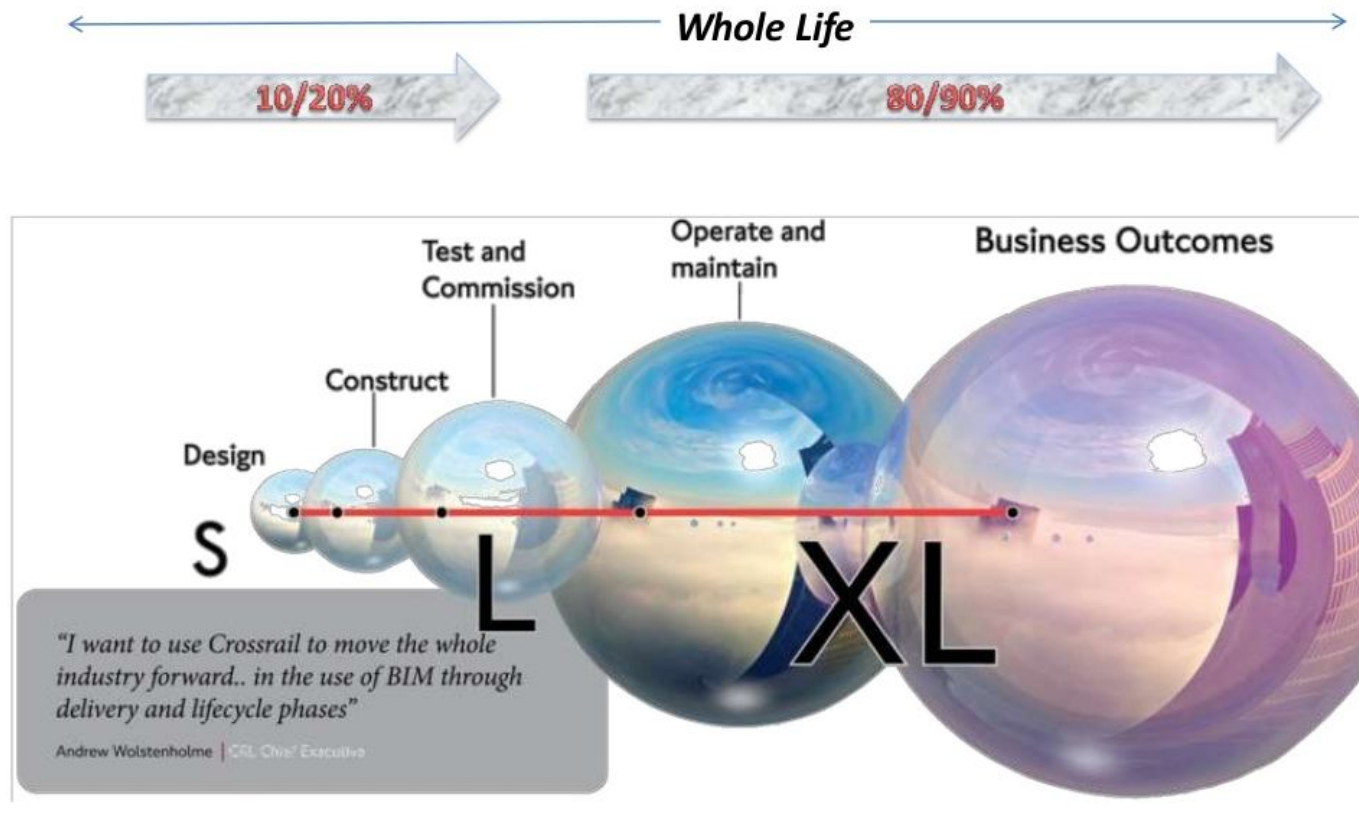
BIM: An Overview



3D/Data Models

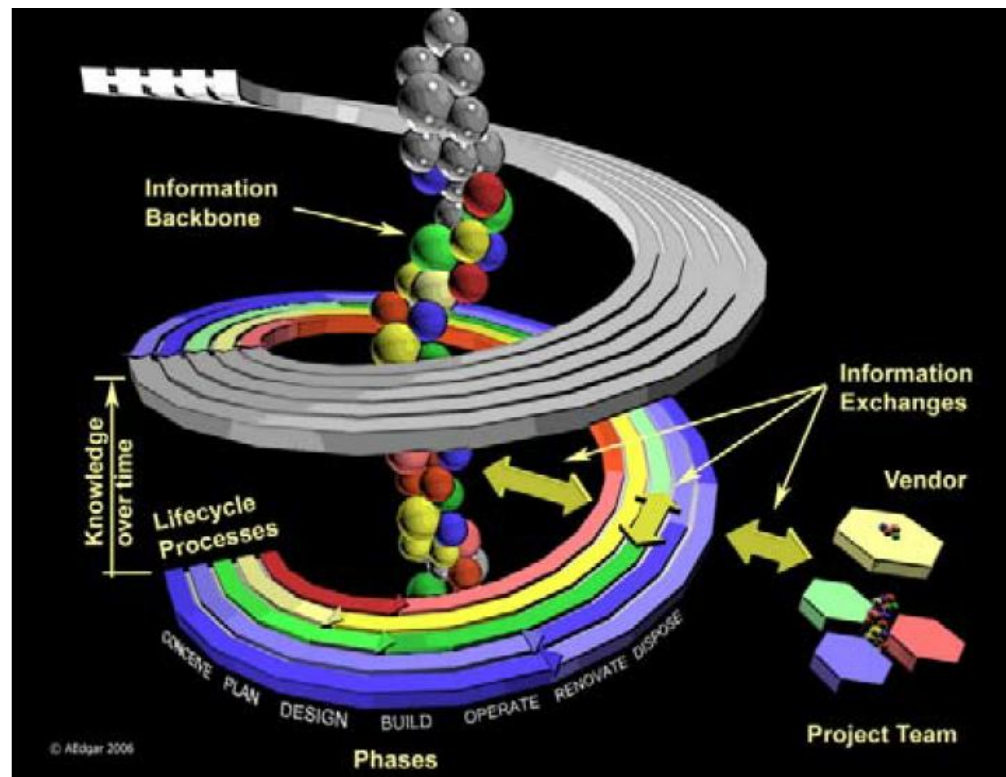


Lifecycle information Management



BIG Data

- Building processes extend throughout and, in many cases, **beyond** the life of a facility.
- The information backbone at the core is made up of **integrated repositories** which provide historical and current data for future projects.



<http://www.wbdg.org>



►► INTRODUCTION

BIM OPEN STANDARDS AND SPECIFICATIONS

- One of the main functions of managing building facilities is assessing the current conditions of these facilities, which begins with the **acquisition of the as-is conditions of building facilities.**
- Accordingly, **BIM open standards and information specification are widely utilized to create as-is conditions BIM models,** which act as a unified 3D models of an existing building facilities that employ data **to portray the current situation of existing building facilities.**



►► INTRODUCTION

PROBLEM DEFINITION

- **Wasting significant time** for gathering data from multiple sectors in hardcopy format where data could be lost or misrepresented.
- Steady **useless task searching** for, sorting, validating and reconstructing existing building facilities data.
- **Expenditures associated** with manual information re-entry, information identification, tasks duplication and unproductive time.
- **Lack of building facilities knowledge** and inadequate management leading to deteriorating building facilities.



▸▸ Agenda

✓ INTRODUCTION

- CETL ACTIVITIES
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►► CETL ACTIVITIES




CETL
Construction Engineering Technology Lab

Construction Engineering Technology Lab
Faculty of Engineering - Cairo University

Software Training Courses
Career Development Courses
Construction Management Services
Building Information Modelling (BIM)
3D Laser Scanning / 3D Printing
Virtual Reality (VR)

cetl.eng.cu.edu.eg/

Training Courses

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Development Courses

n
ment Professional PMP® Preparation
Basics & LEED® Certification Preparation

Management Services

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Scheduling
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Information Modeling (BIM) Services

tation of physical and functional
of facilities for:

- 3D Coordination
- Building Systems Analysis
- Construction Simulation and Visualization
- Design Communication
- Life-Cycle Costing
- Asset Management
- Building Maintenance Scheduling

3D Laser Scanning

Creation of point clouds of data from the
surface of objects and facilities



3D-Printing Service

Creation of 3D printed models
using additive processes



Virtual Reality Modeling

Using 3D environments to create
immersive and engaging learning
experiences for facilities



CETL Equipment

**3D Laser
Scanners**



CETL Equipment



Ground Penetration Radars





Civil Engineering Building CUFE





▸▸ Agenda

✓ INTRODUCTION

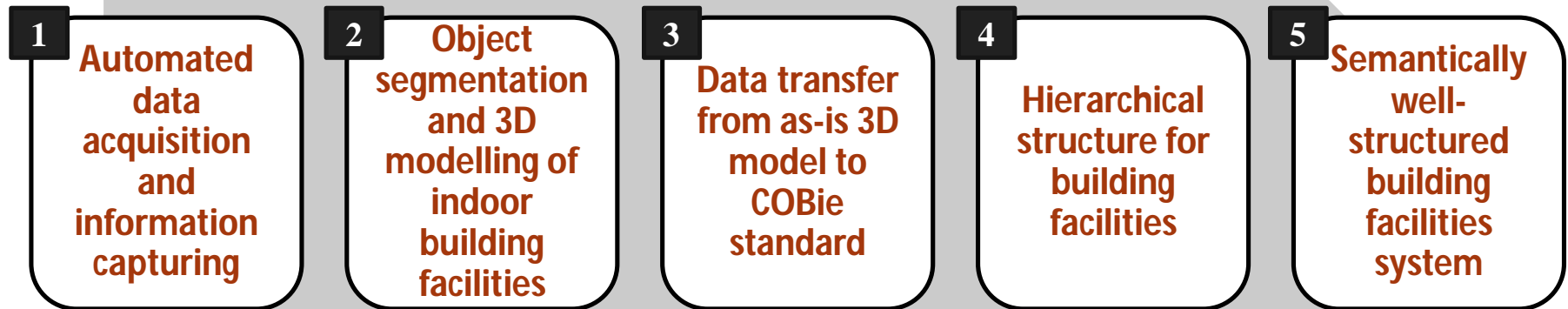
✓ CETL ACTIVITIES

- **PROPOSED FRAMEWORK**

- **CONCLUSIONS**

►► PROPOSED FRAMEWORK

Objective: Fully Integrated Framework for Managing Existing Building Facilities, focusing on as-constructed data and scoping the O&M of current building facilities



Outcome: This research delivers a workflow for installing and portraying owner maintenance demands into and from BIM

►► PROPOSED FRAMEWORK



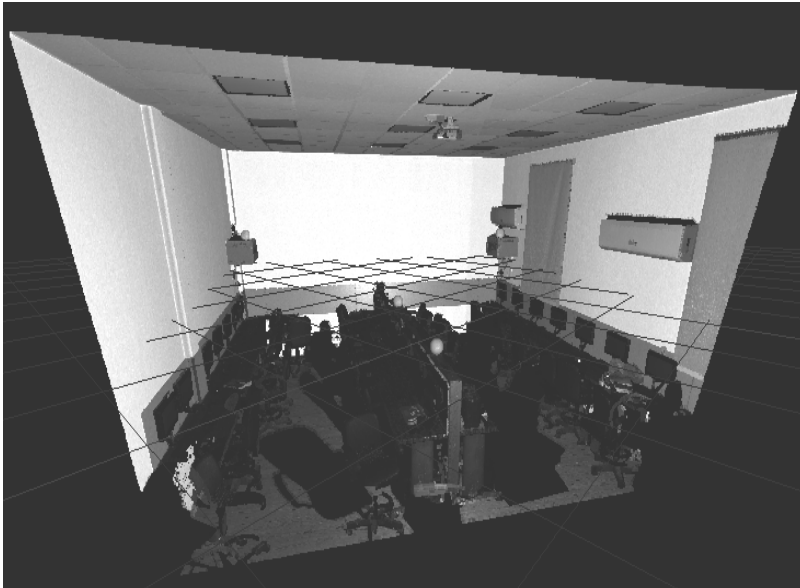
3D INDOOR POINT CLOUDS

Sets of 3D point clouds data acquisition

1- AUTOMATED DATA ACQUISITION AND INFORMATION CAPTURING

- The construction of an as-built 3D model demands the **acquisition of the as-is conditions of the building facilities.**
- The most commonly utilized technique for data scanning and retrieving is **laser scanning using Terrestrial Laser Scanners.**

►► PROPOSED FRAMEWORK



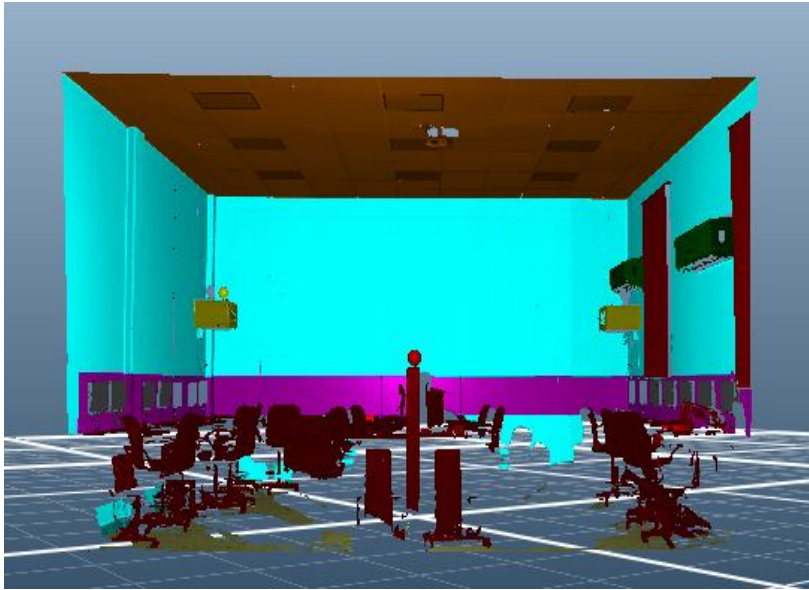
3D INDOOR POINT CLOUDS

Sets of 3D point clouds data acquisition

1- AUTOMATED DATA ACQUISITION AND INFORMATION CAPTURING

- Terrestrial laser scanners are considered fast progressing instruments which:
 - **Reduce Data Acquisition Period.**
 - **Huge Coverage of Information.**
 - **Increase Precisions (6mm/100m).**

►► PROPOSED FRAMEWORK



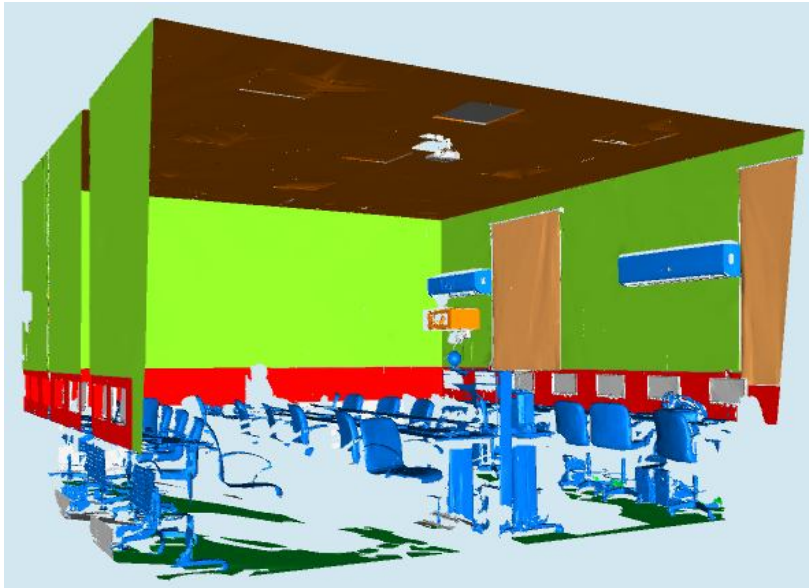
SEGMENTED 3D POINT CLOUDS

Classified and Modeled 3D mesh

2- OBJECT SEGMENTATION OF INDOOR BUILDING FACILITIES

- Scanned 3D point clouds of indoor building facilities results in merged 3D point clouds model.
- Segmentation process is essential in scene clarification and understanding from 3D point clouds information.
- Segmentation process is concerned with splitting 3D point clouds into classified 3D mesh workable clusters with similar properties.

►► PROPOSED FRAMEWORK



SEGMENTED 3D POINT CLOUDS

Classified and Modeled 3D mesh

2- MODELING OF SEGMENTED INDOOR BUILDING FACILITIES

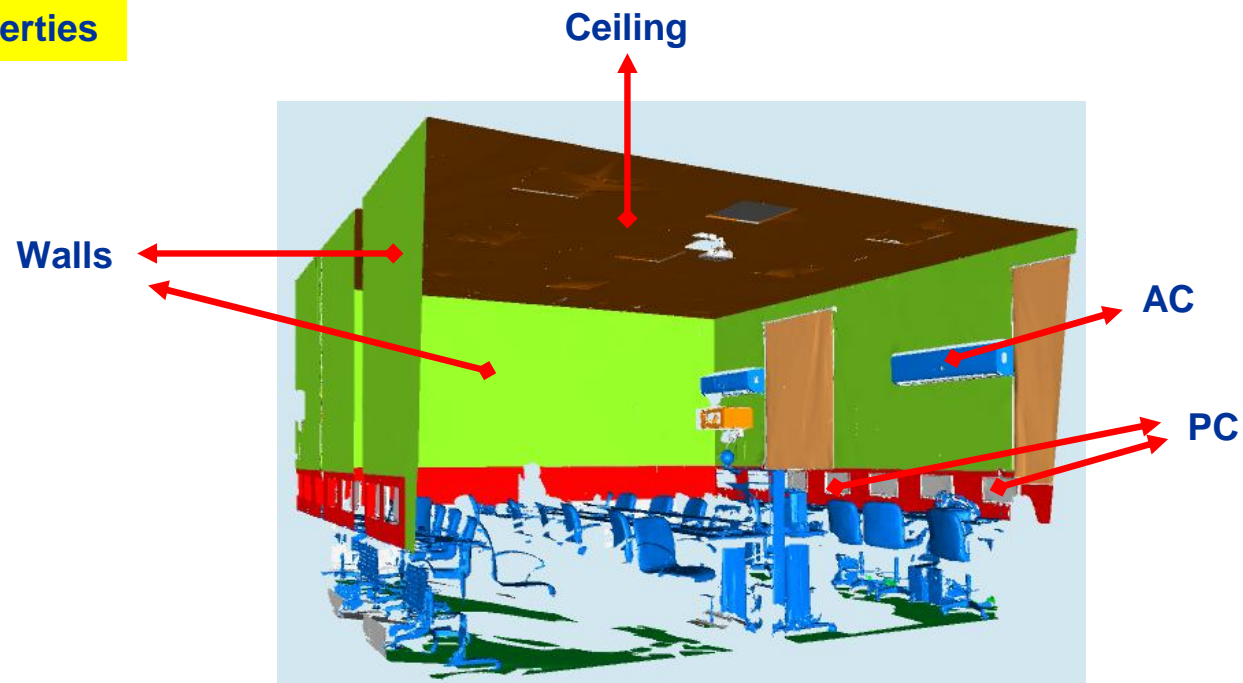
- In this step, segmented objects become a **semantically rich as-is condition BIM**.
- Modeling scanned and segmented 3D indoor point clouds is essential for establishing as-is condition BIM.
- The process of object segmentation and 3D modelling was performed using **Pointfuse software** to generate a fully 3D reconstructed mesh model.



PROPOSED FRAMEWORK

2- OBJECT SEGMENTATION OF INDOOR BUILDING FACILITIES

Clusters with
similar properties



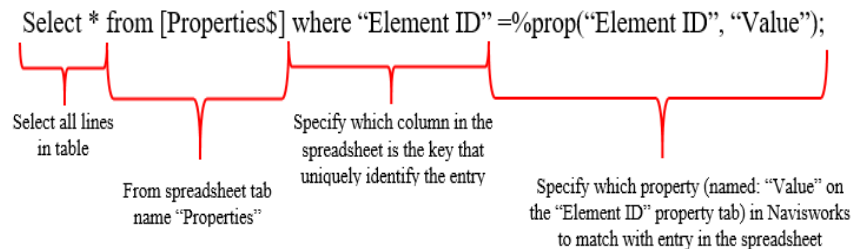


►► PROPOSED FRAMEWORK

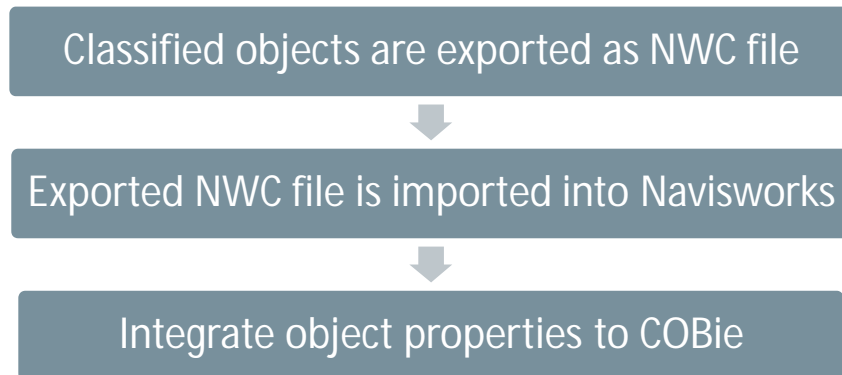
3- DATA TRANSFER FROM AS-IS 3D MODEL TO COBIE STANDARD

- COBie BIM standard is adopted to permit setting up indoor-modeled building facilities to capture vital COBie data of existing building.
- Previously classified objects are used (as-is condition model) to merge these objects with their captured as-is data from COBie spreadsheet.

►► PROPOSED FRAMEWORK



SQL string to link excel data to Navisworks objects

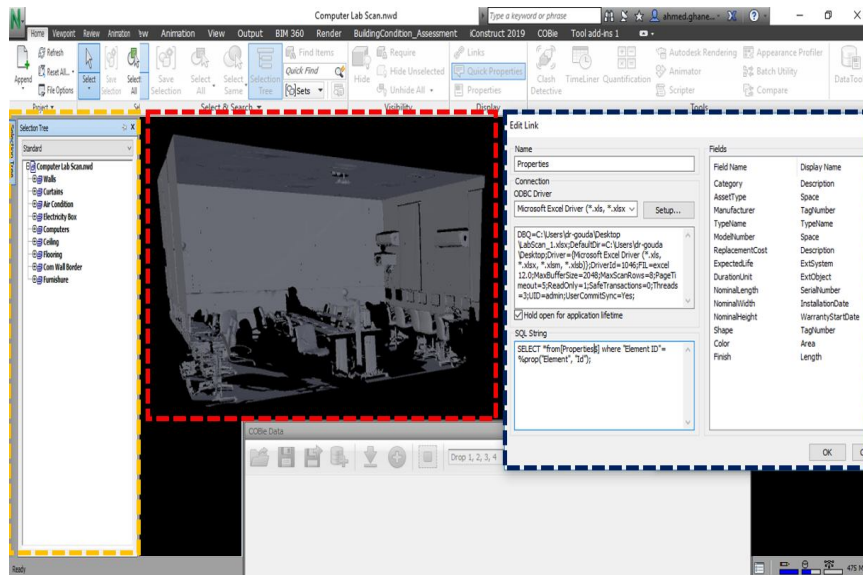


3- DATA TRANSFER FROM AS-IS 3D MODEL TO COBIE STANDARD

- Additional properties of scanned objects are added via employing Selection Inspector and **DataTools within Navisworks** model by creating Properties DataTools Link and **writing a SQL String** to **bond properties with scanned or clustered objects**.
- SQL string integrates the data in the excel COBie file to the applicable elements in the Navisworks file.

►► PROPOSED FRAMEWORK

3- DATA TRANSFER FROM AS-IS 3D MODEL TO COBIE STANDARD



Navisworks Autodesk COBie Toolkit

- Selection tree for the clustered elements in Navisworks
- As is conditions 3D model for the computer lab
- DataTools link using ODBC Driver connection and SQL string

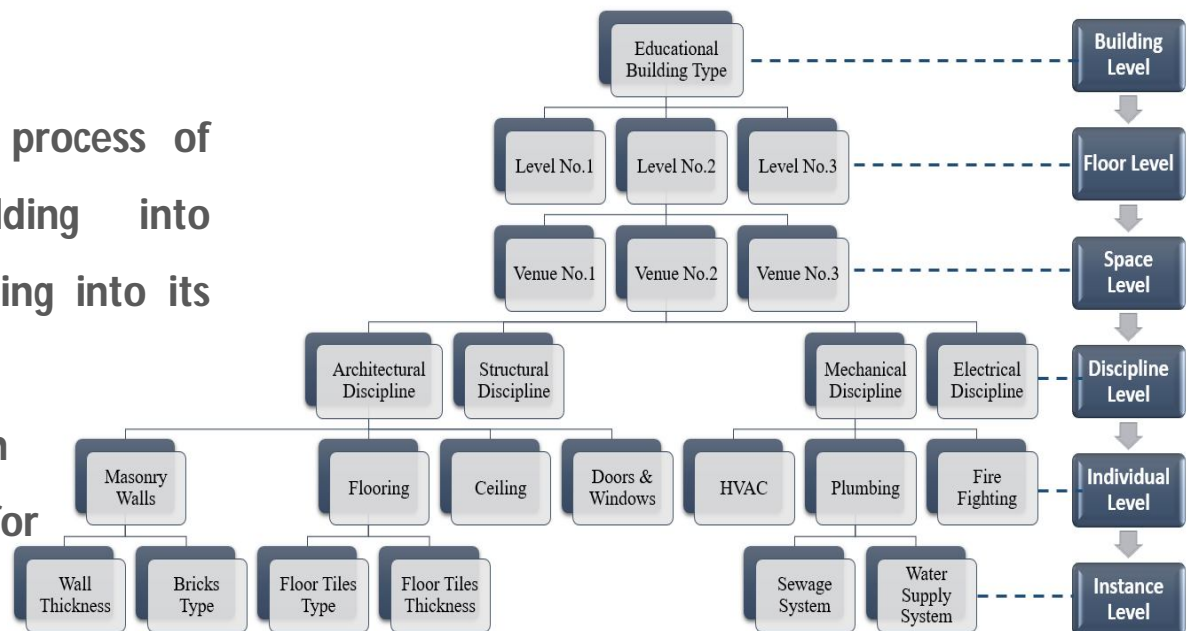
COBie BIM standard

Data Transmission Tool

►► PROPOSED FRAMEWORK

4- HIERARCHICAL STRUCTURE FOR BUILDING FACILITIES

- Hierarchical structure is the process of breaking down the building into **hierarchical shape**, disintegrating into its main components.
- This phase is essential approach to ensure accurate evaluation for enhancing the FM procedures.



Developed hierarchical structure for building facilities



►► PROPOSED FRAMEWORK

4- HIERARCHICAL STRUCTURE FOR BUILDING FACILITIES

Building Level: considers the leading level of the building facilities hierarchy, which resembles the building type, as it can vary for one building to others.

Floor Level: decomposes the building into its floor levels number (e.g., basement floor, ground floor, first floor, etc.).

Space Level: comprises of all the spaces type inside each floor in the building.

Discipline Level: introduces the four main building majors allocated inside each space such as architectural, mechanical, electrical, and structural.

Individual Level: accounts for various elements or work packages below each discipline (e.g., walls, flooring, plumbing, etc.).

Instance Level: includes components properties or data properties per each individual type such as wall thickness, flooring type, and plumbing fixtures.



►► PROPOSED FRAMEWORK

5- SEMANTICALLY WELL-STRUCTURED BUILDING FACILITIES SYSTEM

Aim # 1

- Acquiring optimal M&R plans and minimizing the annual M&R expenditures

Aim # 2

- Determining the optimal time to intervene based on a deterioration models

Aim # 3

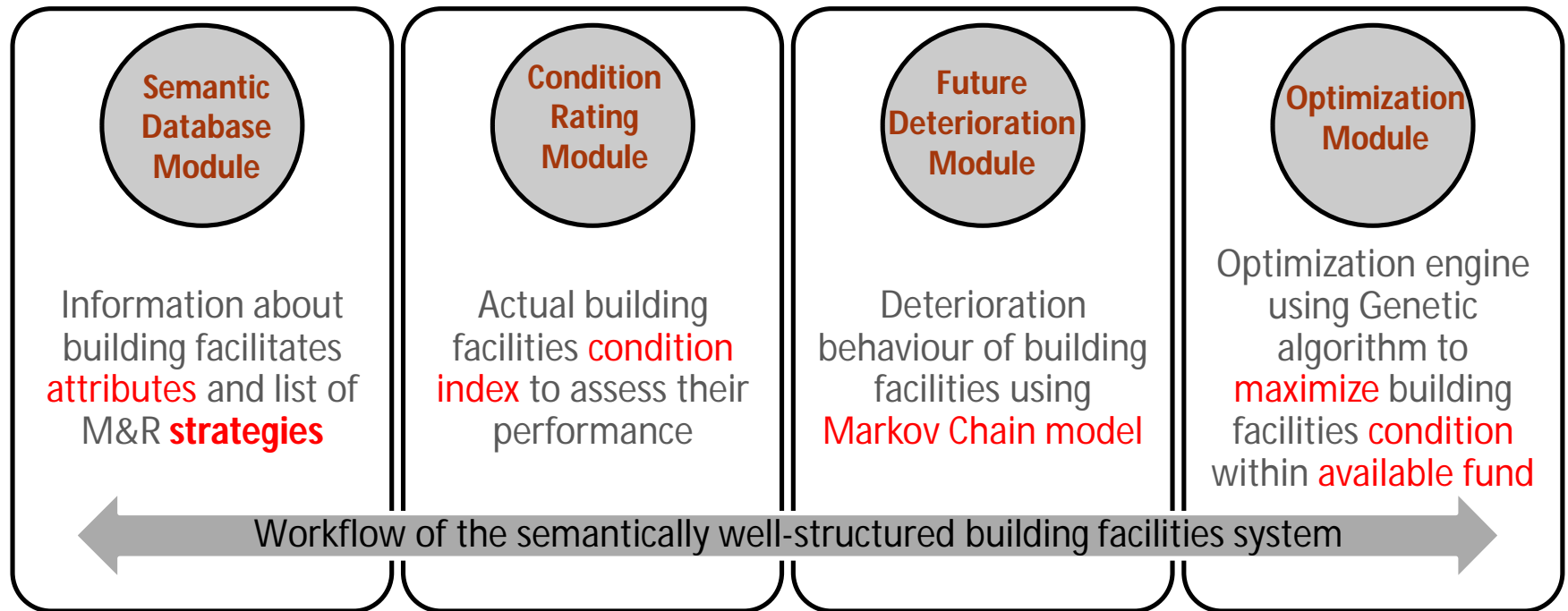
- Minimizing the Life Cycle Cost (LCC) within the available resources using an optimization model

Aim # 4

- Ensuring the optimal budget allocation and funding level to maintain the health of the building

►► PROPOSED FRAMEWORK

5- SEMANTICALLY WELL-STRUCTURED BUILDING FACILITIES SYSTEM





▸▸ **Agenda**

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►► CONCLUSIONS

- Buildings facilities are sustaining their health from consistence maintenance process.
- O&M phase is perceived as the substantial participator to the lifecycle expenditures of building facilities.

Thus This Research Promotes

- BIM open standards to enhance the feasibility of FM functions.
- Development of a fully integrated framework for managing and retrieving existing building facilities focusing on the O&M of current building facilities.
- Guide for facilities managers to deliver a workflow for embedding and extracting building facilities-based data regarding the O&M.



Thank You