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المؤتمر الدولي الثاني والعشرون لإدارة الأصول والمرافق والصيانة
The 22nd International Asset, Facility & Maintenance
Management Conference

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Architectural Digital Twin: Enhancing Building Lifecycle Management through Predictive Maintenance and Restoration

26-28 January 2025
The Ritz-Carlton Jeddah, Kingdom of Saudi Arabia

An Intiative By

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Arab Asset, Facility and Maintenance Management Council

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The Specialist Group • شركة مجموعة المختص

Dr. Nader Mohamed Gharib
Assistant Professor at the Arab Academy for Science,
Technology, and Maritime Transport.

nader.gharib@aast.edu

Research Outlines

- **Introduction**

- **Digital Twin and Building life Cycle: Concept and Applications**

- **Heritage Buildings and Digital Twin**

- **Maintenance Strategies for Digital Twin-Enabled Buildings**

- **Prophet's Mosque Model as a Digital Twin-Enabled Start**

- **Discussion & Conclusion**

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Introduction

Problem

Maintenance represents an economic and environmental burden on building management, and prior assessment of the impact of its phase throughout the building's life cycle contributes to reducing these negative impacts.

Objectives

- Real-time Monitoring.
- Improved Decision-making.
- Cost reduction and Emissions Control

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Digital Twin and Building life Cycle: Concept and Applications

التوائم الرقمي ودورة حياة البناء: المفهوم والتطبيقات

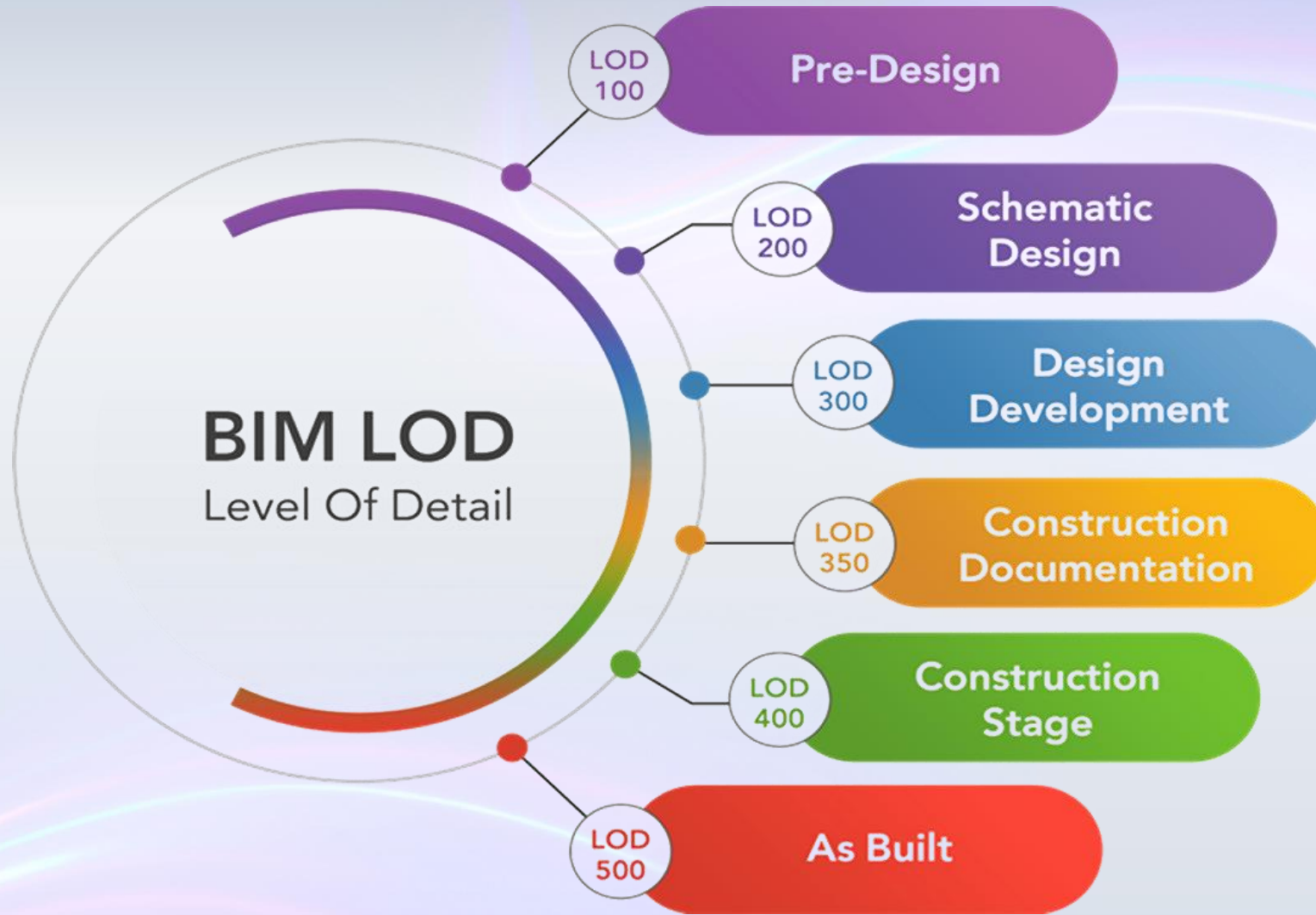Digitization - Excellence - Sustainability

"BIM Dimensions: From 3D Modeling to 7D Facility Management"

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BIM Dimensions source (BuildEXT) - Fourth Dimension of Building Information Modeling (4D BIM

Nagham Salman 2023

BIM Level of details

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www.teslacad.co.uk/bim-services

Stream Building Performance Data

Your digital twin will monitor your building in near real-time by streaming operational data from installed IoT sensors and BMS systems.

1. Your Existing/Historical Building

Many existing buildings do not have accurate or complete as-built documentation, but don't worry, there's a solution.

3. Data Alignment

Using Autodesk ReCap, the individual point cloud scans are properly aligned to generate as built-documentation.
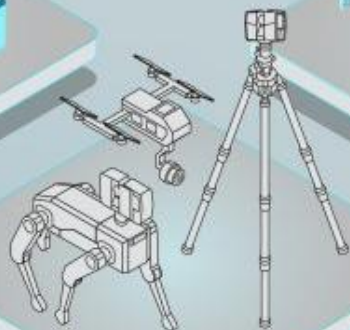
5. Twin Building

Once the BIM model is uploaded to Tandem, Twin Builders tag assets with their associated data, including serial and model numbers, manufacturer specs, O&M manuals, and other desired information.

2. Reality Data Capture

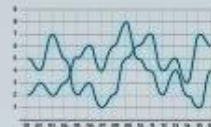By using Reality capture methods, you can quickly and accurately record the geometry

4. From Pointcloud to BIM

By using Revit, you can create a highly accurate modeled geometry of the as-built

6. Insightful Operations

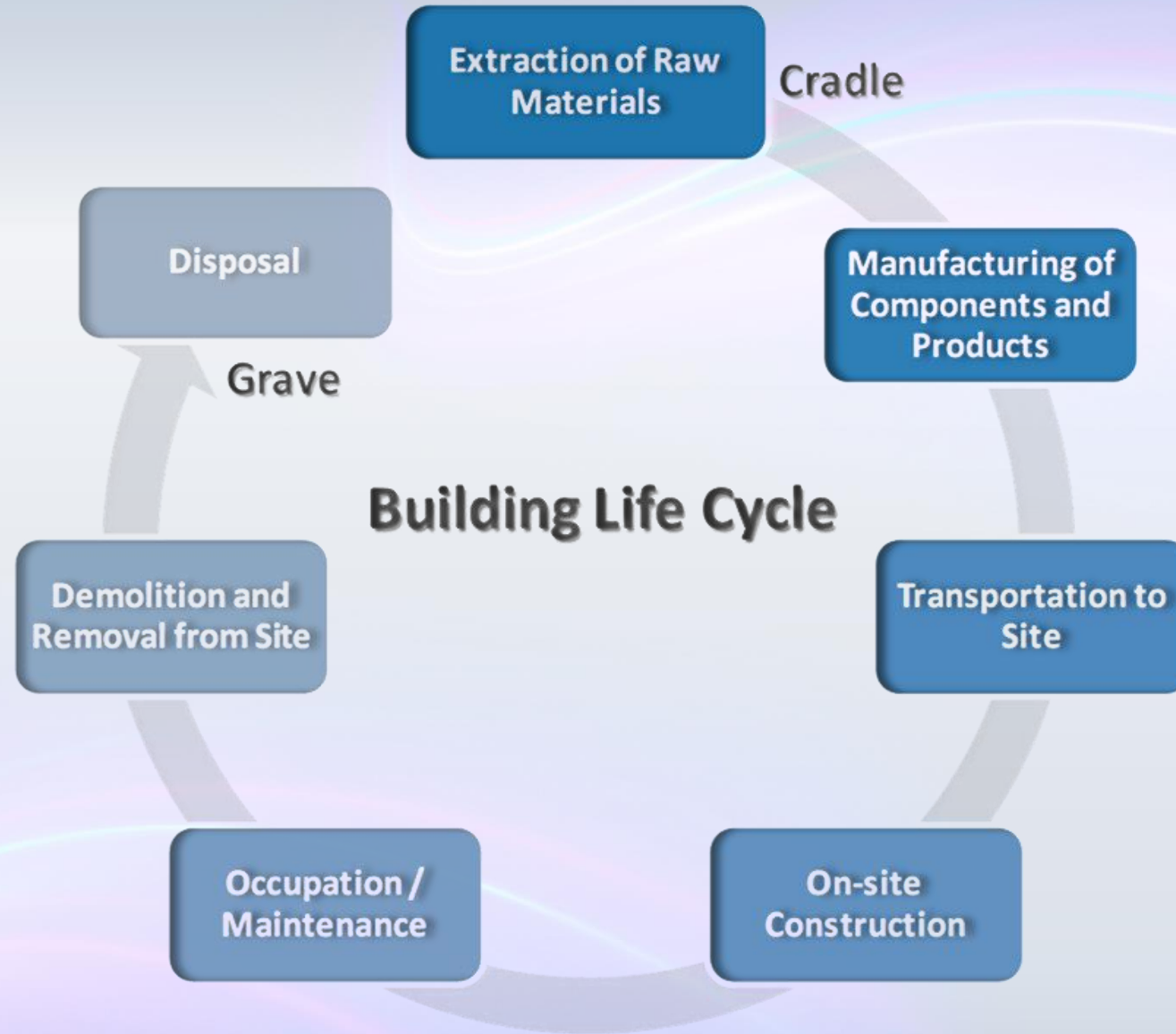Leverage IT/OT data with powerful visualizations to analyze system

What is the difference between a DIGITAL TWIN and a BIM model?

A **Digital Twins** focus on building operations, while a BIM model is for architectural and structural design.
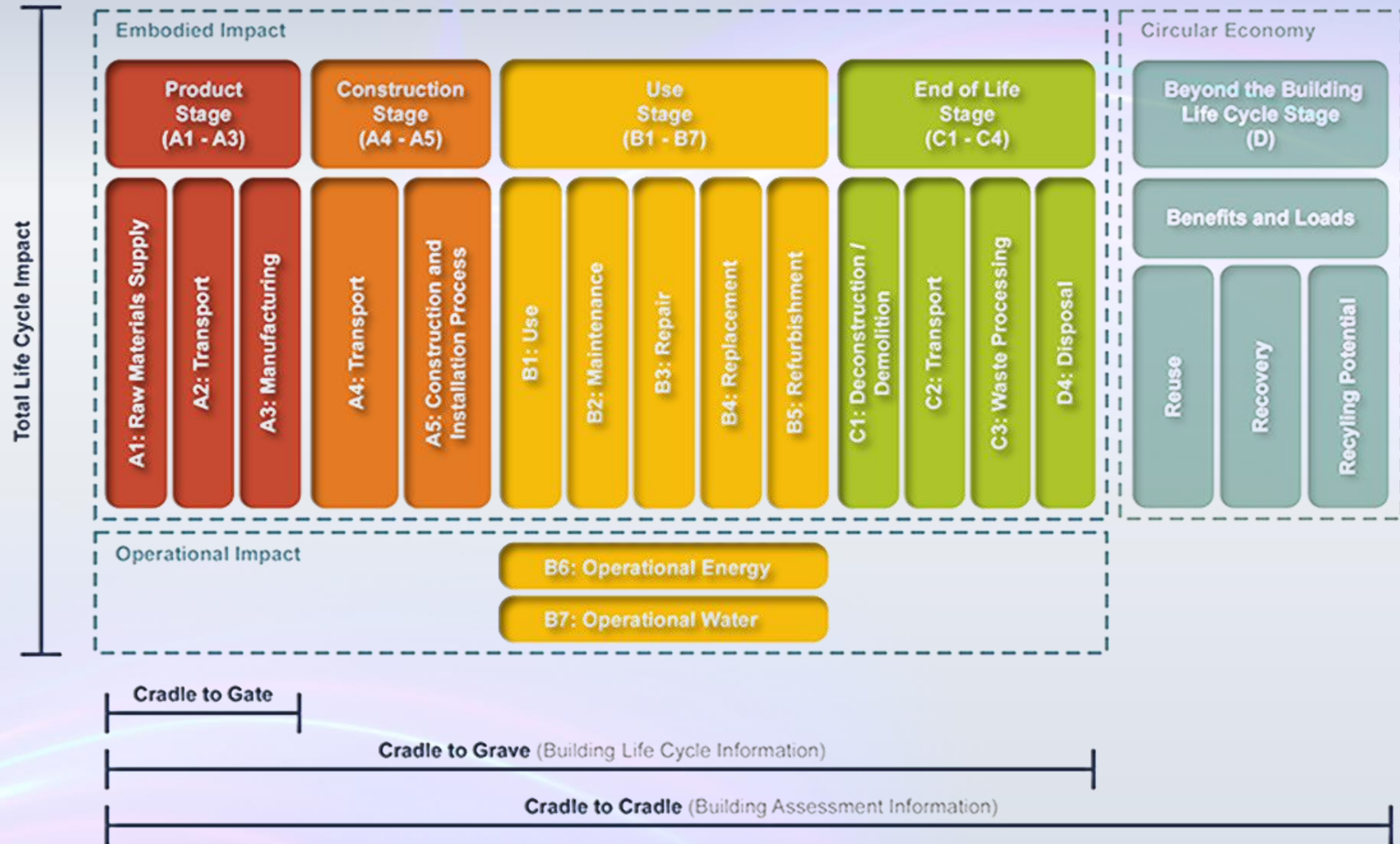
Building life Cycle

دورة حياة البناء

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Building Life Cycle

Cradle: Extraction of Raw Materials → Manufacturing of Components and Products → Transportation to Site → On-site Construction → Occupation / Maintenance → Demolition and Removal from Site → Disposal (Grave)

Stephen Y. C. Yim

Life Cycle Process of a Building

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Stages included in LCA system boundaries

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Lourdes Alameda 2022

Building Life Cycle: Operation and Maintenance Phases (B1-B7)

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Life Cycle Assessment (LCA)

- Evaluates environmental impacts throughout a building's lifecycle.
- Integrates **LCA** with **Digital Twin** for sustainable management.

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Heritage Buildings and Digital Twin

المباني التراثية والتوائم الرقمي

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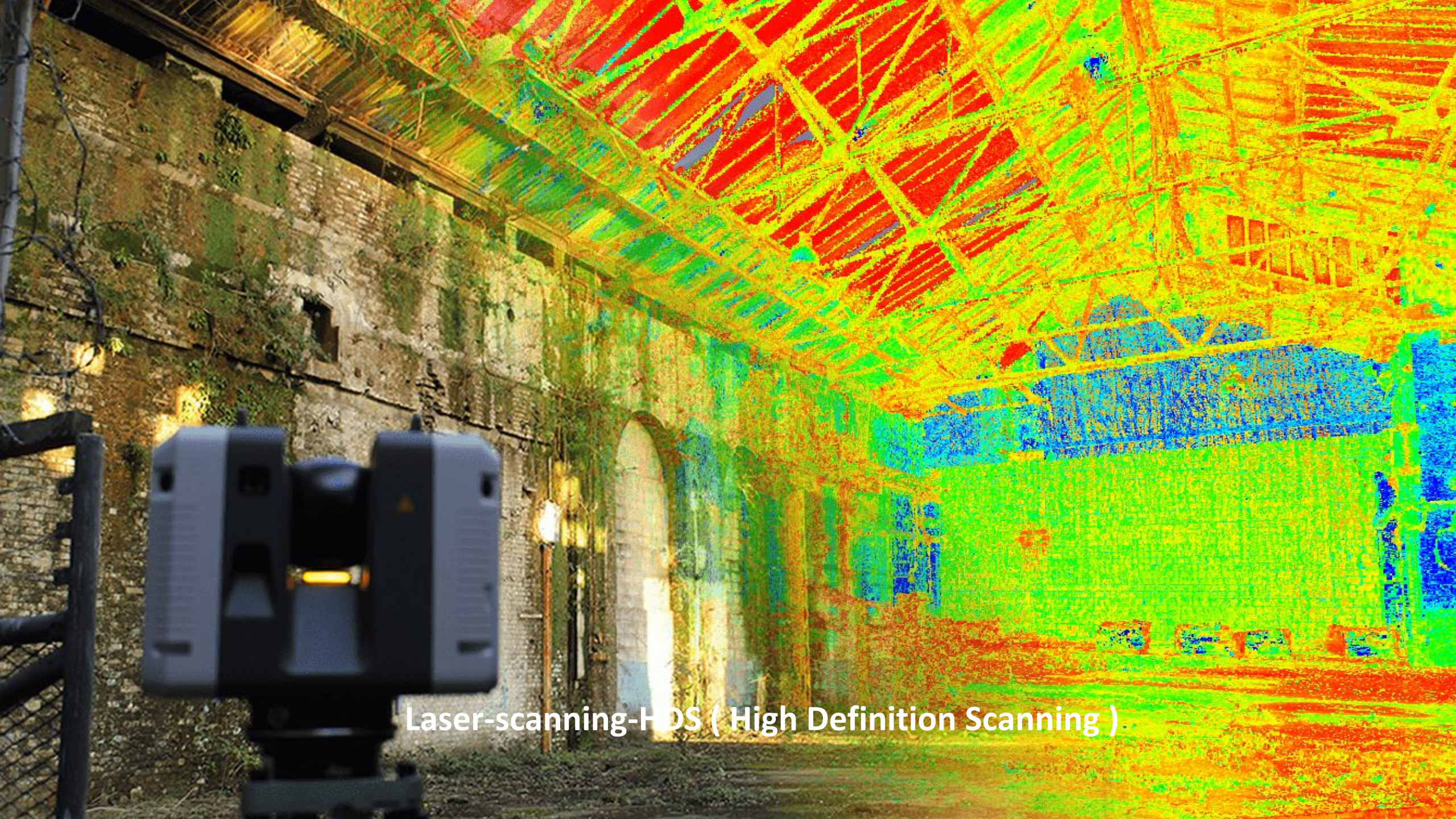
Laser-scanning-HDS (High Definition Scanning)

Digital Twin

Stage One
BIM (Building Information Modeling)

BIM models provide 3D building representations with detailed element information. Basic LCA data integration allows initial environmental impact estimates.

Stage Two
7D Model

Incorporates operational performance, life-cycle cost, and material data, enhancing LCA capabilities with time-based information for more accurate assessments.

Stage Three
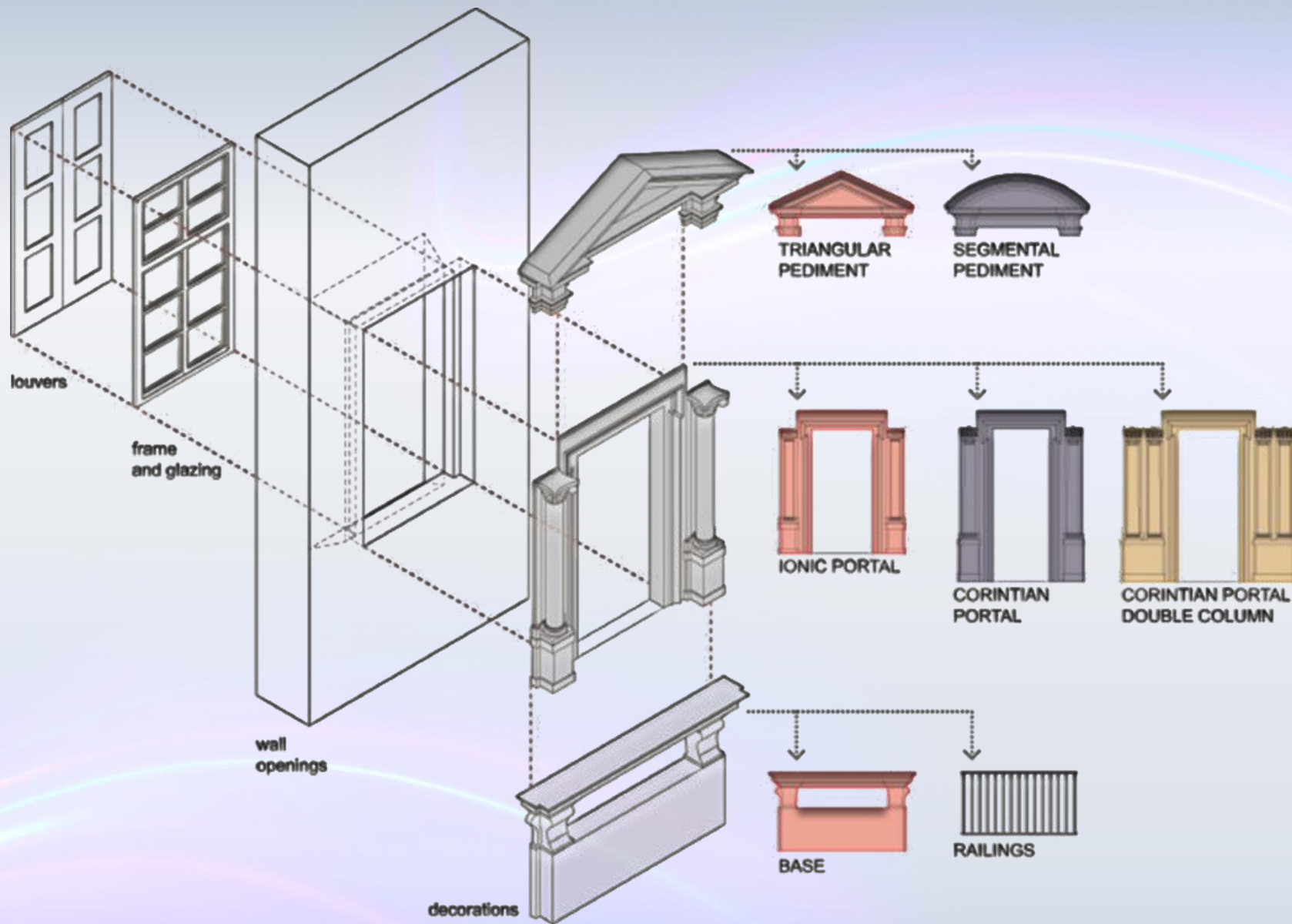### HBIM (Heritage Building Information Model)

Integrates heritage data, enabling specialized LCA for historic buildings, considering preservation techniques and extended lifecycles.

Stage Four
Digital Twin

Links to real-time data, enabling continuous performance analysis and dynamic LCA. This allows real-time sustainability optimization and accurate long-term environmental impact projections

By researcher 2024

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HBIM (Heritage Building Information Model)

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Letizia Martinelli
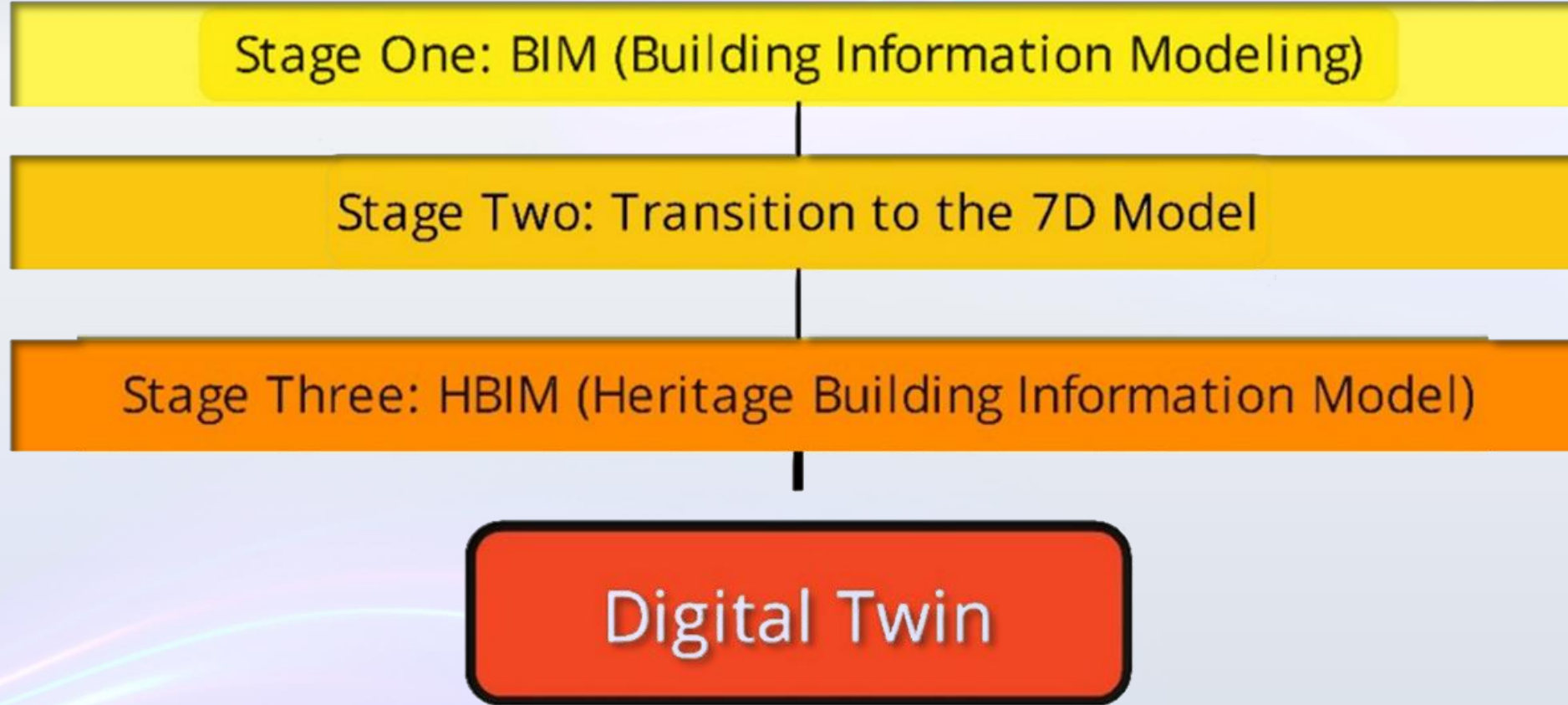
BIM Documentation level

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Importance of Digital Twin

lifecycle Management

- Real-time Monitoring
- Improved Decision-making
- Cost Reduction and Emissions Control

Digital Twin in Heritage Buildings

Transformative Impact

- Creates precise digital replicas for preservation.
- Supports proactive management and enhances public engagement.

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Maintenance Strategies for Digital Twin-Enabled Buildings

استراتيجيات الصيانة للمباني المجهزة بنظام التوأم الرقمي

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The 7 Types of Building Maintenance

1 Preventative Maintenance

2 Corrective Maintenance

3 Predictive Maintenance

4 Routine Maintenance

5 Emergency Maintenance

6 Cosmetic Maintenance

7 Planned Maintenance

Building types of Maintenance

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Preventive Maintenance

This type of maintenance involves scheduled inspections, cleaning, and servicing of equipment and systems to prevent potential issues before they occur. It aims to minimize downtime and extend the lifespan of building components

Restoration Approaches

In-Kind Restoration: Preserving Original Materials

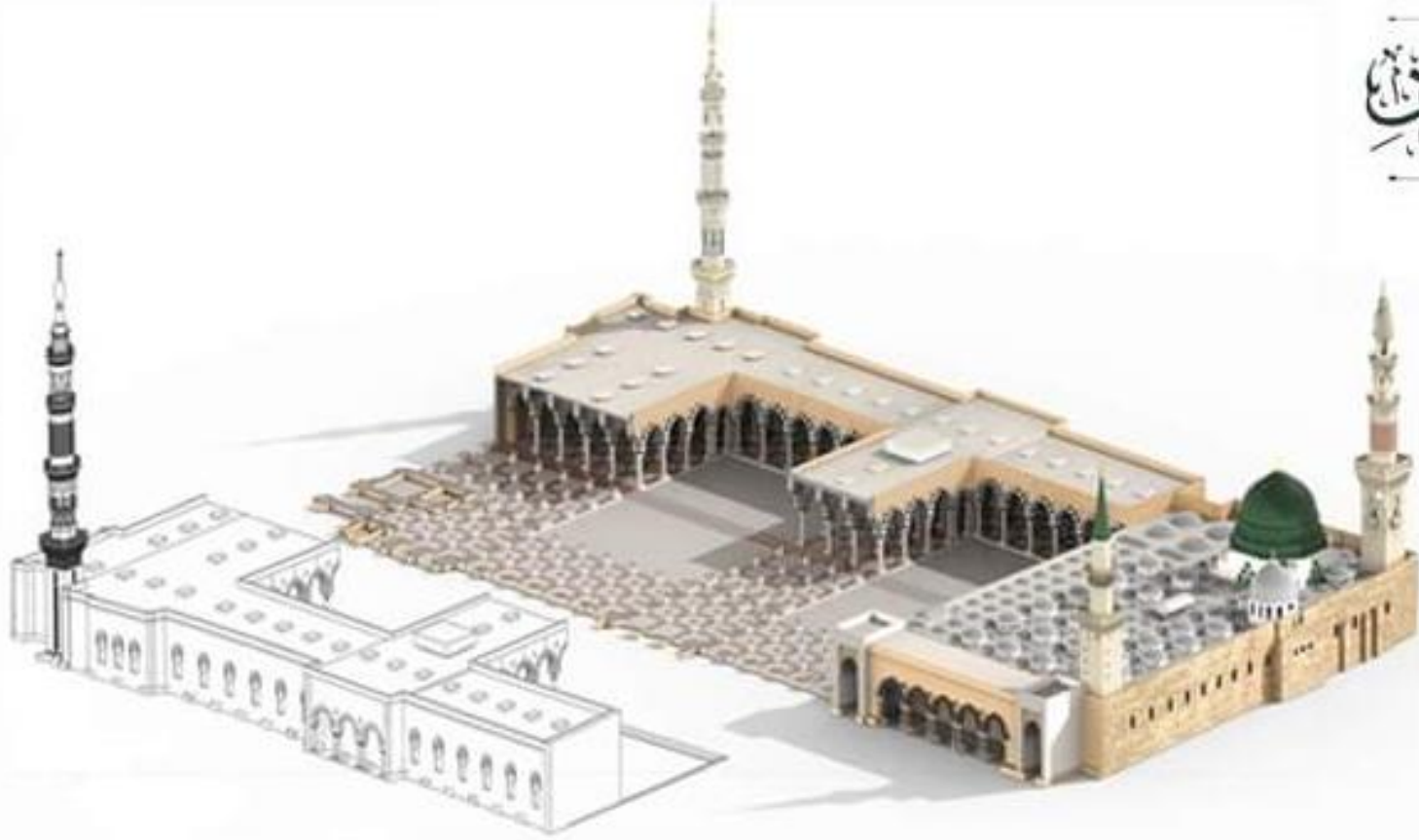Adaptive Restoration: Balancing Heritage and Modernity

Reversible Restoration: Ensuring Future Adaptability

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Architecture of the Prophet's Mosque Encyclopedia

موسوعة عمارة المسجد النبوي الشريف

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موسوعة عمارة المسجد النبوي الشريف

مقطع طولي تخيلي للمسجد النبوي الشريف بعد إتمام التوسعة السعودية الأولى، حافظت هذه التوسعة على التجانس المعماري بين عناصر المسجد، واحترمت بوضوح مبدأ الاستمرارية المعمارية في وحدة وتنوع العناصر.

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Discussion & Conclusion
المناقشة والخلاصة

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The integration between Digital-twin technology and the life Cycle concept of heritage buildings helps enable maintenance and restoration practices to be implemented in more enlightened and efficient ways, thus reducing costs. This can increase the adaptability of these buildings and ensure their continuity for future generations.

In the future, it is expected that digital twin technology will be integrated with other technologies such as artificial intelligence and the Internet of Things to increase the effectiveness and efficiency of heritage building preservation. The role of continuous training programs for influencers and stakeholders in the field of management in general, and building maintenance in particular, stands out regarding these advanced technologies.
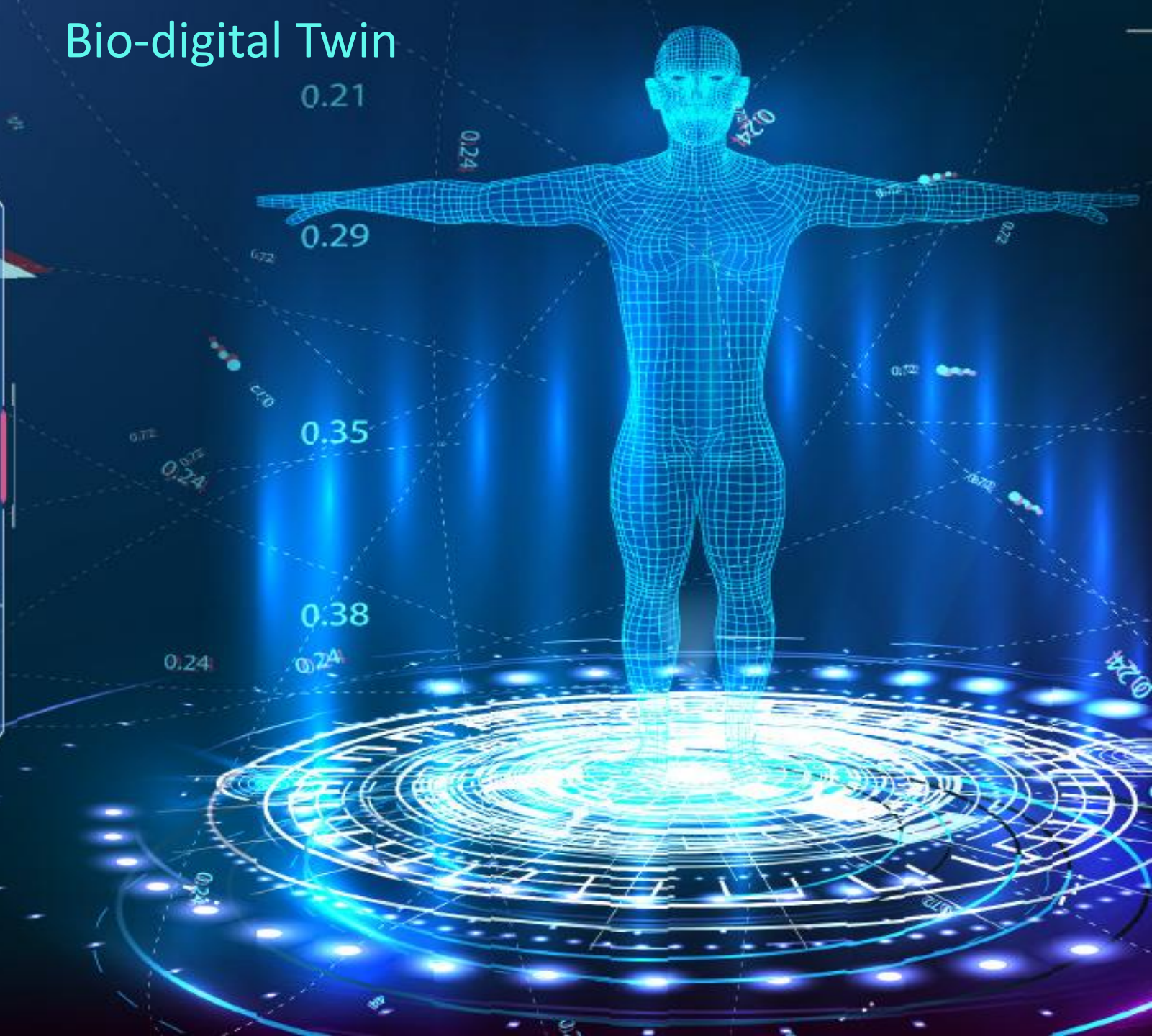
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Bio-digital Twin

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