

**Advanced Construction Technology: A Critical Review and
Retrofit Strategy for the Dylan Thomas Centre, Swansea.**

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[DylanThomas.com 2025]

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1. Introduction

The report aims to provide a critical review of the Dylan Thomas Centre (DTC) in Swansea, focusing on how this complex construction project can be enhanced through the integration of current digital technologies. It is essential to appreciate the whole-life performance of buildings and implement sophisticated management strategies for long-term care and sustainability.

The main objective of this report is to explore how the DTC can be retrofitted with modern technologies to improve facility and asset management. This report will discuss how Building Information Modelling (BIM), which serves as a vital tool for mitigating risk, and managing maintenance and refurbishment cycles. Furthermore, the report investigates the potential for smart building systems, 3D scanning, Artificial Intelligence and digital twins to optimise energy use and evaluate the building's performance throughout its lifecycle.

By identifying age-related defects and typical wear and tear associated with the type of structure, the following digital solutions can be justified to maintain the asset more effectively. This review not only appraises the processes involved in the design and production of complex projects but also proposes a clear framework for upgrading the DTC's facilities management through evidence-based, innovative practices.

2. Building Critique and Performance Analysis

2.1 Building Analysis of the Dylan Thomas Centre

The DTC was originally constructed as Swansea's Guildhall between 1825 and 1829 by Architect John Collingwood and later expanded in 1848 by Thomas Taylor, represent a complex heritage asset [DylanThomas.com 2014]. Critiquing the processes involved in managing such structures

highlights a reliance on fragmented historical records and potentially as-built drawings that may not reflect the physical reality of the site. This fragmentation often complicates the management of the building fabric, making traditional maintenance cycles less effective and increasing the risk of unforeseen site conditions during any modernisation efforts.

2.2 Analysis of Defects

To maintain the DTC effectively, facility managers must appreciate and recognise the whole-life performance of the building, specifically the common defects inherent in 19th-Century masonry.

The historical use of non-breathable cement-based mortars during previous repairs traps moisture within the stone, this leads to surface spalling. Due to the solid wall structure, there is a greater risk of penetrating damp, this then decays the sub-structure of the external walls. Soluble salts from groundwater can enter the stone's pores as water evaporates, this then leads to efflorescence on the surface of the walls. Due to the construction the walls are highly permeable and lack thermal resistance, this will greatly affect the operational performance of the building [Dunbar Heritage 2016 & Old Home Living 2022].



[IDS 2024]

2.3 Whole Life Performance and Management

Undertaking a whole-life approach required moving beyond reactive management towards a proactive management model. Current facilities management at the DTC will often rely on periodic manual inspections which are often reactive rather than preventative. Without integrated digital systems to track the conditions of the asset over time, it remains difficult to justify maintenance budgets or predict long-term expenditure. Successful management must compile and extend knowledge of how the building behaves under modern occupancy loads to ensure its care, management and compliance for future.

2.4 Justification for Technologies

The adoption of modern technologies is justified to manage energy use and evaluate performance throughout the building's lifecycle:

Heritage BIM (HBIM) provides a comprehensive and detailed 3D representation that preserves the historical integrity whilst also enabling clash detection during retrofit works [Bim Services 2025].

Digital Twins integrate IoT sensors, allowing real-time monitoring of humidity and temperature, helping to better monitor heating and ventilation requirements to help reduce energy consumption [MDPI 2025 & Hou, C., Wu, H. and Remoy, H. 2021].

Artificial Intelligence (AI): AI algorithms can analyse occupancy and climate data to optimise ventilation systems, reducing energy waste by an estimated 20-40% in complex buildings while maintaining internal environments required [Zhang, Y. et al. 2026].



[Autodesk 2023]

3. Digital Planning and Risk Mitigation

3.1 The Role of BIM in Planning and Risk Management

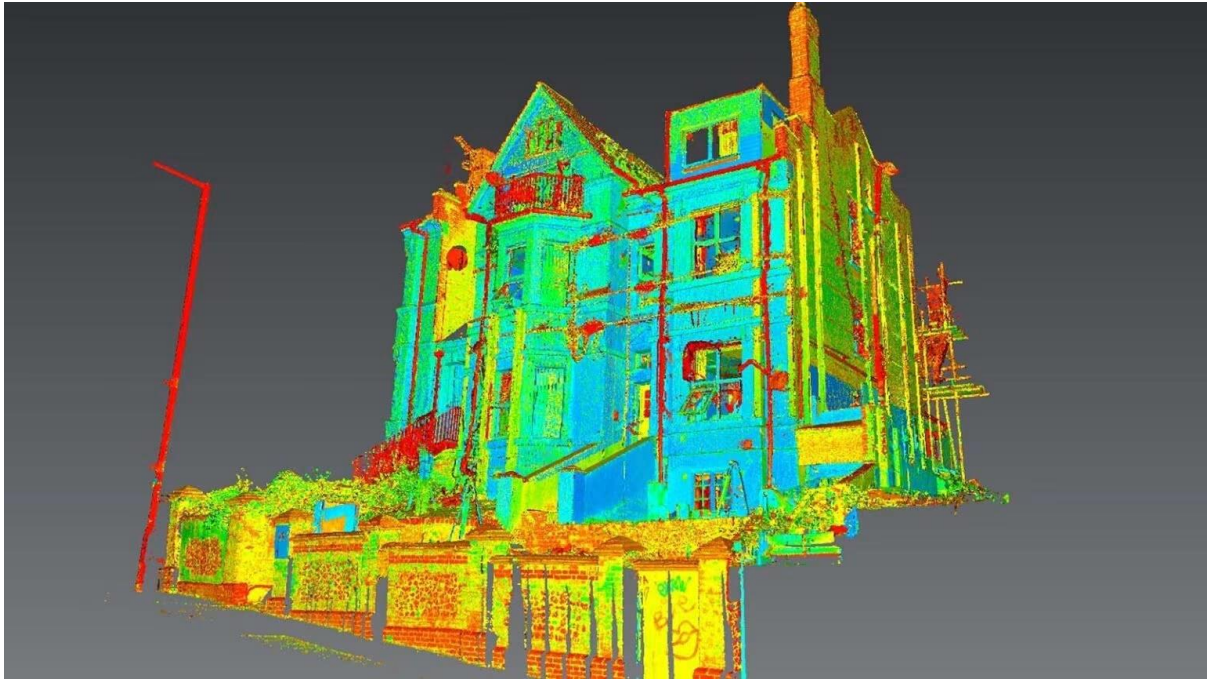
The integration of BIM is essential for planning works and mitigating risk within a project like the DTC. By creating a high-fidelity digital representation of the building, stakeholders can perform sophisticated clash detection, identifying potential conflicts between modern mechanical services, such as HVAC ducts or fire suppression systems and the existing historical structure prior to any works onsite [Autodesk 2024a].

This proactive approach directly addresses the uncertainty often found in heritage projects, as it allows for systematic understanding of structural interfaces that are otherwise hidden behind internal finishes or floor voids. By simulating the construction sequence in a virtual environment, project managers can identify potential issues in complex and unpredictable contexts before they lead to costly delays. Ultimately, BIM acts as a central common data environment, ensuring that all disciplines are working from a single unified model [Historic England 2023a].

3.2 3D Laser Scanning for Data Accuracy

Traditional surveys often fail to capture the subtle deformations and “wear and tear” present in a 19th Century masonry building. Modern scanning technologies, such as LIDAR (Light detection and ranging), can be used to generate accurate point clouds of the DTC, providing a precise foundation for any retrofit or repair strategy moving beyond the limitations of 2D plans [Leica Geosystems 2025]. This level of detail is crucial for:

- **Structural Monitoring:** Detecting minute shifts, leaning or cracking in the masonry over time to prevent and monitor structural concerns.
- **Accurate material quantities:** Reducing waste and cost by precisely calculating accurate quantities for improvement & maintenance schemes.
- **Digital Archiving:** Creating a permanent record of the building’s current state. This serves as a digital record that assists in the programmed future management and preservation of the building’s facade.



[Terrain Surveys 2024]

3.3 Effective Management of Retrofit and Refurbishment

The application of BIM extends beyond the design phase to effectively manage maintenance, retrofit, and refurbishment throughout the building's lifecycle. For the DTC to remain functional, it must adapt to modern standards of energy use and facility management. By linking maintenance manuals and historical data directly to the digital model, facility managers can transfer from reactive to proactive management [RICS 2024]. This is particularly valuable for:

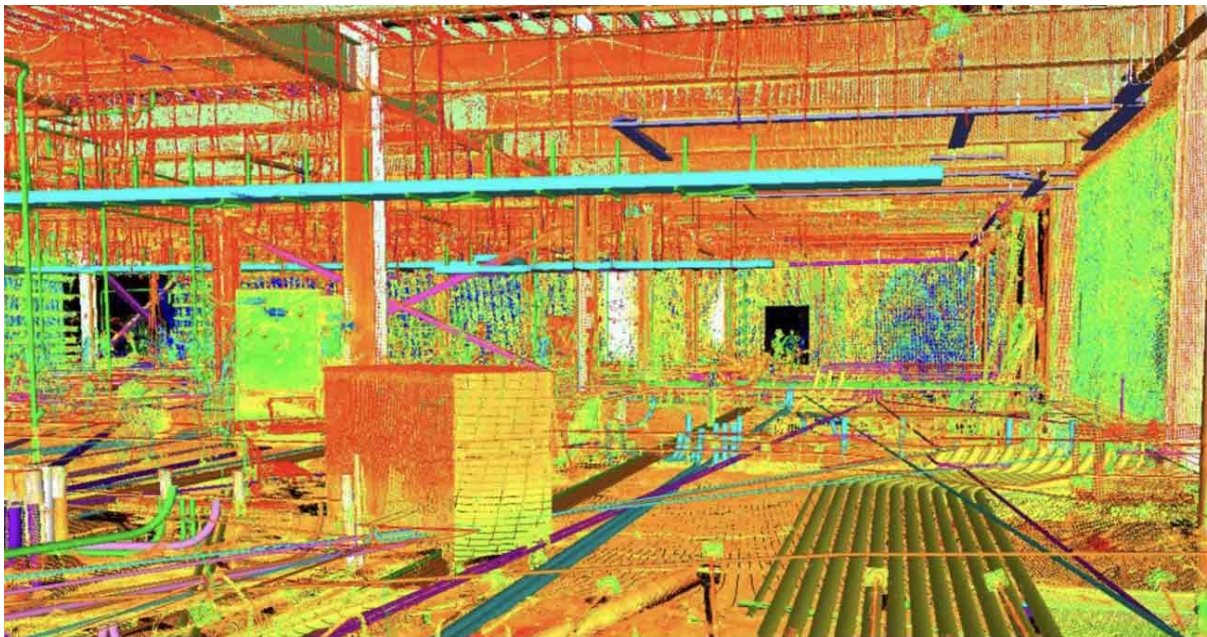
- Retrofit planning: Simulating the installation of energy-efficient systems to ensure they do not compromise the building's aesthetic or structural integrity.
- Repair schedules: Tracking age-related defects and scheduling preventative maintenance to avoid emergency repairs.
- Whole-life performance: Evaluating how specific refurbishments contribute to the building's overall sustainability and longevity.

3.4 Justification of Technological Specification

The primary justification for adopting BIM and scanning technologies is the ability to mitigate the inherent risks associated with the DTC's unpredictable historic structure. Using these tools demonstrates the

ability to research, present, and propose effective technologies for real-world applications.

By utilizing BIM and LIDAR technologies, a 3D model can be generated to include all information required by the facility manager to make informed decisions evidence-based decisions on improvement schemes. While the initial investment in scanning may be higher than traditional methods, the reduction in unforeseen site conditions that cause budget overruns in heritage projects provides a clear economic and practical validation for their use. This federated 3D model also allows for maintenance registers to be developed, allowing for proactive repairs to be scheduled throughout the property's life cycle. This technological suite ensures that the DTC's facilities management is successfully improved and aligned with current industry's best practices.



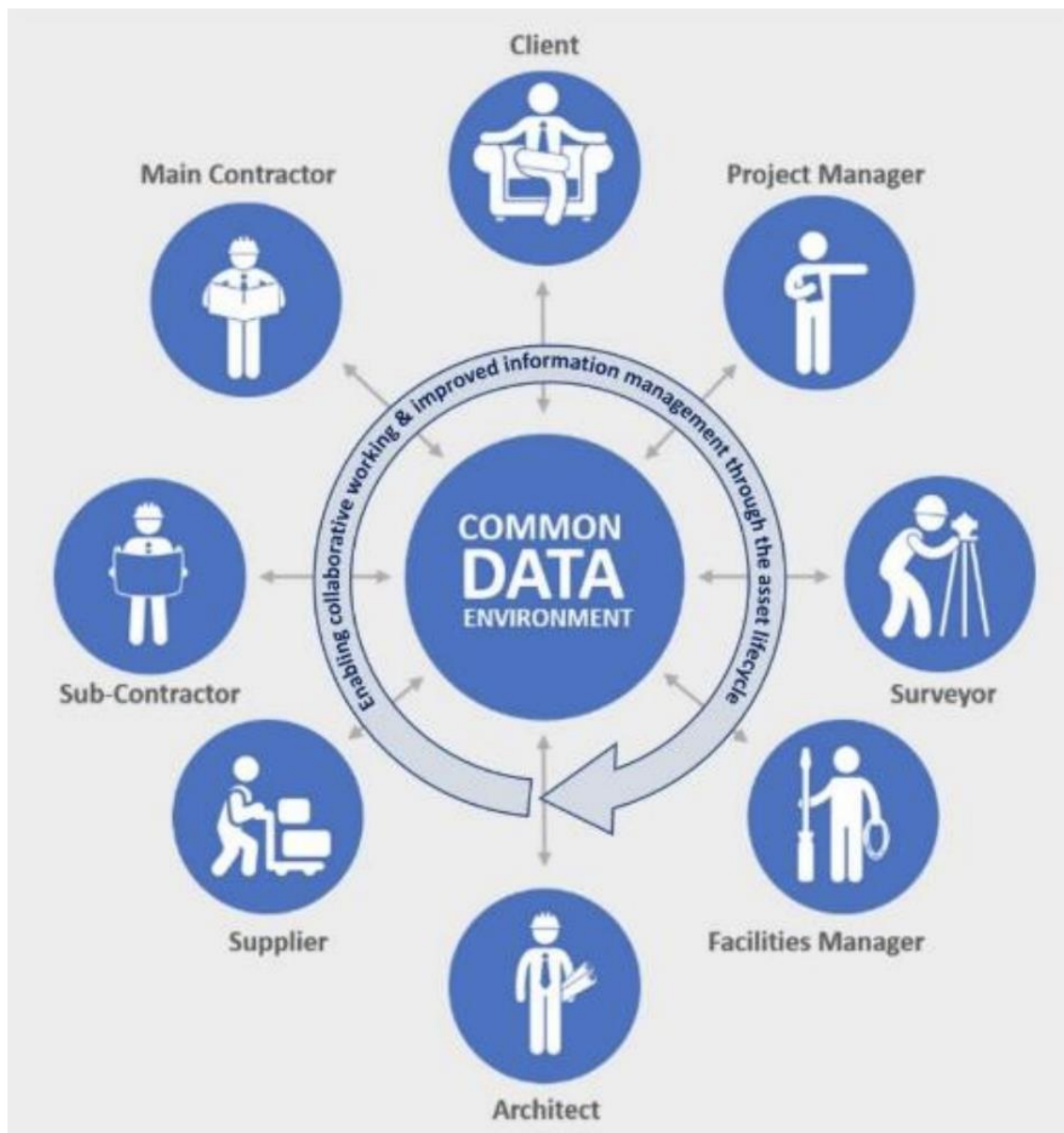
[EIWAA 2025]

4 Proposed Retrofit Strategy for the Dylan Thomas Centre

4.1 Implementation Framework: Incorporating Modern Technology

To successfully improve the facility management and operational performance of the DTC, a phased approach to the above digital technologies is proposed. The foundation of this strategy involves moving

from fragmented paper-based records to a Level 2 BIM environment. This establishes a central common data environment (CDE), which serves as the single source for all future maintenance and improvement schemes. A cloud-based CDE allows the seamless integration of structural, architectural, and mechanical data [Autodesk 2024b]. This is particularly useful for retrofit and improvement schemes for the DTC where the complexity of the aged structure leaves very little service voids for the installation of modern mechanical services without altering the building's aesthetic.



[Autodesk 2023]

Following the creation of the digital model, smart sensors should be installed throughout the facility. These IoT devices can be utilised to monitor real-time environment data such as humidity, temperature, and CO2 levels which can be fed back into the BIM model. This integration creates a real-time digital twin; this allows facility managers to identify performance gaps and address them in real-time [Hou, C., Wu, H. and Remoy, H. 2021]. This approach allows for the management of building infrastructure as it allows managers to identify potential moisture ingress or thermal bridging issues through the changes in environmental conditions, helping to manage potential structure issues.



[Azolla 2024]

4.2 Justification and Technical Evaluation

The specification of these technologies is justified by the need to balance modern standards with the preservation of the heritage of the DTC. The use of automated monitoring is best practice for identifying moisture trends within a heritage building to identify moisture permeation through solid walls [RICS 2024].

By utilising AI driven building management systems, the DTC can optimise the heating and cooling cycles based on real-time occupancy patterns. This helps to reduce unnecessary energy consumption which directly

improves the building's whole-life performance and sustainability [Zhang, Y. et al. (2026)].

By developing a predictive maintenance register the facility management can move away from reactive break-fix cycles. The digital twin allows for the generation of predictive maintenance registers ensuring that operational costs of the building can be anticipated and budgeted for. Additionally, environmental conditions can be reviewed to ensure the building is meeting modern standards [BSI 2023].

Modern retrofitting must comply with modern regulations; BIM allows for the simulation of fire exit strategies and the placement of modern-life saving systems in a way that reduces minimal visual impact on the DTC's aesthetic [Watts, A 2023].

While the initial cost of implementing these sensors and software is significant, the long-term reduction in emergency repair costs clear financial justification. Precise digital models allow for accurate material take-offs and accurate measurements to be utilised to provide effective costs for improvement schemes [Historic England 2023b].

4.3 Critical Feasibility Analysis and Limitations

While these technologies offer a sophisticated solution for managing the DTC, their application to a 19th century structure requires a critical evaluation of limitations.

It must be noted that some intrusive sensor installations or high visibility MEP upgrades may not be suitable for the DTC due to its protected status and architectural significance. Any retrofit scheme must be minimally invasive to avoid damaging the fabric of the building.

A major challenge is ensuring that the digital model remains functional over the building's lifecycle. The DTC's management team must commit to consistent data updates and software training due to ever-evolving technologies. This will prevent the digital twin from becoming a static record.

The high initial cost of LIDAR scanning and BIM development must be weighed against the long-term benefits. In the case of DTC, the value of

developing a maintenance register and accounting for programmed costs as well as using onsite sensors with a digital twin outweigh the upfront technological investment.

In summary, the proposed retrofit strategy utilises BIM, IoT and AI tools to transition the DTC from an outdated heritage building into a high-performance modern asset. This approach ensures that the facilities management is not only improved but is resilient enough to face the environmental and structural challenges in the future.

5. Conclusion

The critical review of the Dylan Thomas Centre underscores the necessity of transitioning from traditional, reactive maintenance models to a sophisticated, data-driven management framework. The original 19th-century construction, while architecturally significant, presents complex challenges, for instance fragmented records and age-related defects such as masonry spalling and thermal inefficiencies. By introducing a phased retrofit strategy centered on Heritage BIM (HBIM) and LIDAR scanning, the DTC can move beyond these limitations, replacing "unforeseen site conditions" with a high-fidelity digital archive that serves as a permanent foundation for all future works.

The integration of Digital Twins and IoT sensors provides a transformative solution for the building's whole-life performance. By monitoring real-time environmental variables such as humidity and CO₂ levels, facility managers can proactively identify structural threats like moisture ingress before they lead to decay. Furthermore, the application of Artificial Intelligence offers a clear pathway to sustainability, with the potential to reduce energy waste by 20-40% through optimized, occupancy-based climate control.

While initial capital investment in these technologies is significant, it can be justified by the long-term reduction in emergency repair costs and the ability to generate precise, predictive maintenance registers. The feasibility of this strategy relies on a minimally invasive approach that respects the

DTC's protected status while ensuring the digital model remains a living asset through consistent updates. Ultimately, utilizing BIM, AI, and smart technologies ensures that the Dylan Thomas Centre is not merely preserved as a relic of the past, but is successfully retrofitted into a resilient, high-performance asset capable of meeting modern operational and environmental standards.

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