

APPLICATION OF DIGITAL TECHNOLOGIES FOR THE RETROFIT AND MANAGEMENT OF THE DYLAN THOMAS CENTRE

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01 Introduction

Managing existing buildings is a major challenge in the construction industry, particularly when dealing with ageing infrastructure, inefficient maintenance practices, and increasing sustainability demands (IEA, 2021). Buildings such as the Dylan Thomas Centre (DTC) in Swansea highlight this challenge, as they must balance cultural value with modern performance expectations. As these buildings age, issues such as material deterioration, poor energy efficiency, and incomplete asset information become more common, often leading to higher lifecycle costs and reduced performance (Douglas, 2006).

In response, digital technologies are being used more widely to improve how buildings are planned, refurbished, and managed (Whyte and Hartmann, 2017). Tools such as Building Information Modelling (BIM) and laser scanning are helping to create more accurate representations of existing buildings, while emerging technologies such as artificial intelligence (AI) and digital twins offer new ways to improve performance and decision-making. However, introducing more technology does not automatically result in better outcomes. In some cases, overly complex systems can be difficult to manage and may not be fully utilised in practice.

This report explores how BIM and related technologies could be applied to the Dylan Thomas Centre. It evaluates their role in improving planning, reducing risk, and supporting facilities management, while also considering their limitations. It also examines how smart technologies, AI, and digital twin concepts can improve energy efficiency and long-term performance. Finally, a practical and balanced retrofit strategy is proposed.



(King, 2026)

02 Building Overview

The Dylan Thomas Centre (DTC) is a public and cultural building that faces many of the challenges associated with ageing infrastructure. While it holds architectural and cultural importance, it was not designed to meet modern standards for energy performance, digital integration, or advanced facilities management. As a result, its performance is often limited by outdated systems and a lack of reliable building information.

A key issue is age-related deterioration. Over time, building elements such as roofs, façades, and mechanical systems naturally degrade, leading to problems such as water ingress, heat loss, and increased maintenance requirements (Douglas, 2006). In many cases, maintenance remains reactive, meaning issues are only addressed once they become visible or result in failure. This approach can lead to higher costs and disruption for building users.

Traditional inspection methods can also be limited, particularly in hard-to-access areas such as roofs and upper façades. As a result, defects may not be identified until they become more serious. Technologies such as drone (UAV) surveys and thermal imaging provide more effective ways to assess building condition. Drone surveys allow high-resolution images and 3D data to be captured safely, making it easier to identify defects such as cracking, weathering, and material degradation. Thermal imaging can reveal issues such as heat loss, insulation failure, and moisture ingress, which are not always visible during standard inspections (Asdrubali et al., 2014; Balaras and Argiriou, 2002).

Another major challenge is the lack of accurate building data. Older buildings often rely on incomplete or outdated drawings, making it difficult to fully understand existing conditions before refurbishment. This increases uncertainty during planning and raises the risk of unexpected issues on site.

Energy inefficiency is also a concern. Older systems are often not optimised, and without real-time monitoring it is difficult to identify where energy is being wasted (de Wilde, 2014). However, inefficiency is not only a technical issue. Occupant behaviour can also have a significant impact, as building users may override systems or use spaces in ways that increase energy demand.

Overall, these issues highlight the need for more proactive and data-informed approaches to building management.

Figure 1 – Building Exterior / Façade
The existing external façade shows signs of ageing, which may contribute to thermal inefficiency and ongoing maintenance requirements.(King, 2026)



Figure 2 – Windows Condition
Some elements of the building envelope where heat loss and material deterioration may occur. (King, 2026)



03 BIM

Building Information Modelling (BIM) is widely used to support planning and coordination in construction projects, particularly in refurbishment and retrofit scenarios (Eastman et al., 2018; Arayici et al., 2011). It enables the creation of a digital representation of a building, combining physical and asset data in a shared environment. This improves collaboration between stakeholders and supports more informed decision-making. BIM has also been shown to reduce project risk and improve coordination across disciplines (Eastman et al., 2018; Succar, 2009).

For existing buildings such as the DTC, BIM is particularly effective when combined with laser scanning. This technology produces accurate point cloud data, which can be used to develop an as-built BIM model. This provides a more reliable understanding of existing conditions and reduces reliance on outdated drawings (Volk et al., 2014). The scale and complexity of the building façade, as shown in Figure 1, highlight the benefits of using drone surveys and laser scanning to capture accurate building data.

One of the main advantages of BIM is its ability to identify clashes between building systems before construction begins. This is especially important in retrofit projects, where space constraints and unknown conditions increase the likelihood of conflicts. By resolving these issues early, BIM can reduce rework, delays, and overall project costs.

BIM can also be extended through 4D and 5D modelling, linking the model to time and cost data. This allows project teams to visualise construction sequencing and manage budgets more effectively. In addition, BIM can support long-term asset management by acting as a central source of building information throughout the lifecycle.

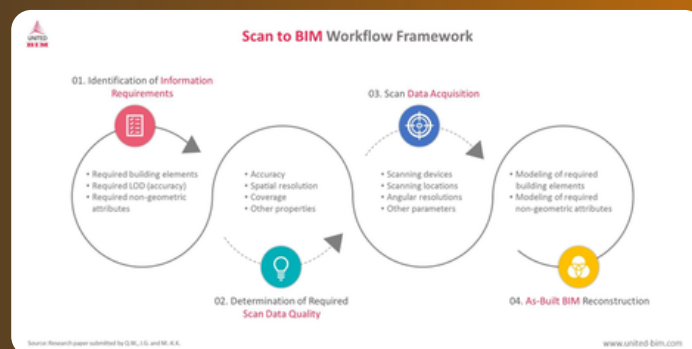


Figure 3- Showing the BIM Workflow that should be utilized in DTC (Patel and Patel, 2025)

Despite these benefits, BIM implementation in existing buildings can be challenging. Developing accurate as-built models can be time-consuming and may be affected by incomplete data or limited access to certain areas. There are also cost implications, particularly for smaller projects, and the need for skilled personnel to manage BIM processes. For this reason, a proportionate approach is important, where the level of detail and investment reflects the needs of the project rather than aiming for unnecessary complexity.

04 Smart Technologies

Smart technologies and AI offer significant potential to improve building performance, particularly through real-time monitoring and data analysis. IoT sensors can collect data on temperature, occupancy, air quality, and energy use, which can then be used to optimise building systems through a Building Management System (BMS) (GhaffarianHoseini et al., 2016). This can reduce energy waste and improve comfort for building users.

AI can build on this by analysing data to predict equipment failures and optimise system performance. This allows maintenance to shift from reactive to predictive, reducing downtime and long-term costs (Zhang et al., 2019). Machine learning techniques can also identify patterns in building performance over time, allowing maintenance strategies to be refined as more data becomes available (Lu et al., 2020).

However, technology alone does not determine building performance. Occupant behaviour plays a significant role, and even advanced systems can be ineffective if they are not used properly. For this reason, simple measures such as user feedback systems and clear controls can be just as important as more advanced technologies.

Digital twins represent a more advanced approach, combining a digital model with live data to simulate and monitor building performance (Bolton et al., 2018; Tao et al., 2019). While this offers clear benefits, a full digital twin may not be practical for a building like the DTC due to cost and complexity.

Digital technologies also support sustainability goals. BIM and smart systems can be used to monitor both operational and embodied carbon, helping to inform decisions that align with net zero targets (IEA, 2021; UNEP, 2020).

There are also risks associated with increased reliance on digital systems, including system failures, data security concerns, and the potential for technology to become outdated. The use of occupancy data may also raise privacy concerns, particularly in public buildings. These factors highlight the need for careful implementation and management.

Figure 4 – Thermostat / Control Panel

The existing control systems, which may lack the intelligence and automation required for optimal energy performance. (King, 2026)



Figure 5 – Tablet / Digital Interface

Digital interfaces are present within the building; however, their effectiveness depends on integration with wider building systems. (King, 2026)



Figure 6 – Motion Sensor
A example of installed but unused smart technology, demonstrating the gap between system installation and effective utilisation. (King, 2026)



05 Limitations

While digital technologies offer clear benefits, their implementation in existing buildings is not without challenges. One of the main issues is cost, as technologies such as BIM modelling, sensor installation, and data management systems require significant upfront investment. For smaller projects or public buildings with limited budgets, this can restrict the extent to which these technologies can be applied.

Another key challenge is the requirement for skilled personnel. The effective use of BIM, AI, and smart systems depends on having trained professionals who can manage and interpret the data generated. Without this expertise, there is a risk that systems are underused or mismanaged, reducing their overall effectiveness.

Data quality and integration also present challenges. Incomplete or inaccurate data can lead to unreliable outputs, particularly in predictive systems. In addition, integrating multiple technologies into a single system can be complex and may create compatibility issues.

Finally, there is a risk of over-reliance on technology. While digital tools can support decision-making, they should not replace professional judgement. A balanced approach is therefore essential to ensure that technology enhances, rather than complicates, building management.

06 Net Zero and Sustainability

In addition to improving operational performance, the integration of digital technologies also supports wider sustainability goals. Buildings are responsible for a significant proportion of global carbon emissions, making it essential to reduce both operational and embodied carbon. BIM can be used to model and assess carbon impacts throughout the building lifecycle, enabling more informed decision-making during retrofit projects.

Smart technologies further support this by providing real-time energy data, allowing building performance to be continuously monitored and optimised. This ensures that systems operate efficiently and reduces unnecessary energy consumption. In the context of the DTC, improving energy efficiency through data-driven systems could significantly reduce operational carbon emissions while maintaining user comfort.

However, it is important to consider the environmental impact of digital technologies themselves. The production, installation, and maintenance of sensors and digital systems also carry a carbon cost. As a result, a balanced approach is required to ensure that the environmental benefits outweigh the impacts associated with implementation.

In addition to reducing operational carbon, retrofit strategies should also consider embodied carbon within building materials. Retaining and upgrading existing structures, rather than demolishing and rebuilding, can significantly reduce the environmental impact of construction projects. In this context, the reuse of existing materials and components becomes an important consideration.

Digital tools such as BIM can support this process by recording material information and enabling better planning for reuse or recycling. This aligns with circular economy principles, where materials are kept in use for as long as possible. For a building such as the DTC, which already has cultural and historical value, retaining and improving the existing structure represents both an environmental and practical advantage.

However, achieving these benefits requires careful planning and coordination. Trade-offs may be necessary between performance improvements and conservation requirements, particularly where heritage features must be preserved. This highlights the need for a balanced approach that considers environmental, functional, and cultural factors together.

07 Retrofit Strategy

A phased retrofit strategy is the most effective approach for improving the Dylan Thomas Centre (Bullen and Love, 2011). Rather than implementing all changes at once, a staged process allows costs, risks, and disruption to be managed more effectively.

The first stage should focus on understanding the building. Laser scanning and detailed surveys can be used to develop an accurate BIM model. Drone surveys can also inspect external elements such as roofs and façades, allowing condition data to be captured safely and efficiently. Thermal imaging can help identify heat loss, insulation gaps, and moisture issues within the building fabric (Asdrubali et al., 2014).

Drone surveys can also be combined with photogrammetry to generate detailed 3D models of building surfaces. When repeated over time, this allows changes in condition to be tracked, helping to identify deterioration before it becomes a major issue. This supports a shift from reactive to predictive maintenance.

The second stage involves installing smart monitoring systems, including sensors and smart meters, to collect real-time data on building performance. This enables facilities managers to identify inefficiencies and adjust systems based on actual usage patterns.

Following this, targeted upgrades to building systems can be carried out, including improvements to the BMS, replacement of lighting with LED systems, and optimisation of heating and ventilation. However, these upgrades must be balanced with the building's cultural and architectural significance (Historic England, 2017). Integrating facilities management systems is also important. Linking BIM with a CAFM system allows assets to be tracked more effectively, supporting maintenance planning and lifecycle management. This can also support circular economy principles by recording materials for future reuse (Akanbi et al., 2018).

While digital twins could be considered in the future, a simpler system combining BIM, sensor data, and monitoring technologies is likely to provide better value at this stage.

Cost and value must also be considered. Although digital technologies require upfront investment, they can deliver long-term savings through improved efficiency and reduced maintenance. A selective approach is therefore essential, focusing on technologies that provide the greatest benefit.

Future-proofing should also be considered. Systems should be adaptable, allowing upgrades as technologies develop and reducing the risk of obsolescence.

When implementing digital technologies, it is important to assess not only their technical benefits but also their economic viability. While technologies such as BIM, smart sensors, and AI can improve efficiency, the initial investment may not always be justified.

For the Dylan Thomas Centre, budget constraints are likely to influence decision-making. Prioritising cost-effective interventions, such as energy monitoring and predictive maintenance, is therefore essential to achieve the best return on investment.

Operational complexity must also be considered. Simpler systems that are easy to use and maintain may be more effective than advanced solutions requiring specialist knowledge. This reinforces the need for a practical and proportionate approach.

Overall, this approach allows the building to be continuously monitored and improved over time. As more data is collected, strategies can be refined, enabling the building to function as a responsive and evolving system.

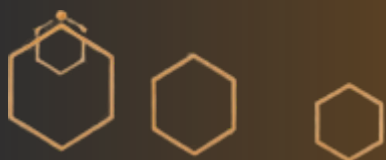
07 Retrofit Strategy



Figure 10 – Boiler Plant Room
the building relies on traditional heating systems,
which may be inefficient compared to modern
alternatives. (King, 2026)



Figure 11 – HVAC / Ventilation Plant
Existing large-scale ventilation
systems, which could be optimised
through real-time monitoring and
control. (King, 2026)



08 Conclusion

This report has explored how modern technologies can improve the performance and management of the Dylan Thomas Centre. It has shown that traditional approaches are often limited by incomplete information, reactive maintenance, and inefficient systems.

BIM and laser scanning provide clear benefits in improving planning and reducing risk, while smart technologies and AI support more proactive building management. However, these technologies must be applied carefully. Overly complex systems can reduce effectiveness, and factors such as user behaviour and organisational capability must also be considered. Observations from site visits (Figures 1–11) demonstrate that while the building contains a range of systems, these are not fully integrated, reinforcing the need for a coordinated, data-driven retrofit strategy.

The proposed retrofit strategy demonstrates that a phased and balanced approach is the most appropriate solution. By focusing on accurate data, practical technologies, and ongoing improvement, the DTC can achieve meaningful and sustainable performance improvements.

Ultimately, the most effective approach is not to adopt every available technology, but to select and integrate those that provide real value, ensuring the building can continue to adapt and perform effectively over time.

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