WHITE PAPER

Smart, Sustainable Asset Management

How digital innovation is paving the way

From AI, BIM, cloud technology, digital twins, robotics, wearables, and extended reality (XR),

the shift to a data-centric world is accelerating our progression towards truly smart assets.

Emerging technologies are transforming asset management, leading to a digital disruption of how they are managed. These technologies are constantly changing how our world is being designed, built and supported, with asset management being radically altered by innovations that were once unimaginable.

Smart asset management is the latest digital disruption, and it's not difficult to see why. Digital solutions have enabled stakeholders to gain valuable insights from their physical assets, enhancing collaboration and innovation across the entire asset lifecycle. The visibility of relevant, quality data in real-time has allowed projects to be delivered with more control and predictability, helping minimise risk and reduce conflicts and cost. With improved data intelligence, better decisions can be made during the asset's operation, leading to enhanced performance, predictive maintenance, reduced risk, and improved sustainability.

These tools can help mitigate some of the issues created by non-digital, non-connected information and systems, such as

- Inaccurate or missing data
- Labour intensive paper-based workflows
- The inability to visualise complex, vertical and horizontal asset structures.

Without a holistic inventory of all assets and their condition, maintenance is purely reactive, rather than preventative or predictive. In turn, this provides less financial control and predictability, which increases both cost and risk. It is also much harder to implement sustainable, energy efficient solutions effectively when working in a disconnected manner and with no clear plan.

Asset managers are facing many challenges, such as stricter environmental and safety regulations, data compatibility and sharing issues, and increasing requirements that must be delivered despite limited resources and expertise. In this climate, the need for sustainably and efficiently operated assets has never been more critical. However, the latest digital solutions can help improve data intelligence, worker safety, profit margins, utilisation figures and sustainability, delivering better outcomes for our organisations, employees, and communities.

1. Based on **Tytheridge, F., 2021. Sustainable water through smart asset management.** Water New Zealand, (222), pp.69-72.

Asset management challenges

Managing any type of asset, be it buildings, utilities, or transport infrastructure, is a complicated process. Often, assets are made-up of diverse portfolios within complex systems, making it difficult to realise their full potential and manage them effectively across their lifecycle. Yet, poor asset management quickly leads to time and cost overruns, as well as unforeseen and unplanned capital expenditure and operational expenditure.

In a time when asset owners and operators are under increasing pressure to deliver an enhanced service provision and performance with an ever-decreasing budget, thorough planning and effective management is crucial.

Achieving these goals requires overcoming some of the main challenges that make asset management more difficult than it needs to be.

Poor strategic planning

The main challenge that asset managers face is, without an effective and holistic inventory of all assets, strategic planning is almost impossible. Maintaining an overview of all assets and their condition is critical to developing an asset management strategy. Without this, it is much harder to analyse asset data and gain the insights that would provide the basis for evidence-based decisions regarding asset criticality, condition, and performance. An understanding of the assets' current condition and historical performance is required to predict how they will perform and what investment they may require in the future. Otherwise, there is a constant reactive cycle of unforeseen expenses as assets break or require servicing.

In addition this also adversely affects regulatory compliance. In the UK, public infrastructure is heavily regulated, with regulators increasingly demanding more accountability from operators for their capital and operational expenditures, as well as performance data. When preparing investment plans, regulators such as OFWAT are moving to more outcome-based measures as opposed to outputs[2], which in-turn requires deeper asset insights.

Ineffective data management

Linked to the previous challenge, effectively aggregating, analysing, and sharing asset data is another common issue. While most organisations have some level of data management in place, this information is often held in different silos or non-connected systems. Not only does this make accessing data more difficult, but it also means that sharing data with other stakeholders can lead to the loss of crucial asset information. For more complex assets, fragmented asset information makes cross-asset data analysis and management extremely difficult, and much harder for different teams to add value.

In addition, the long lifespan of most infrastructure assets presents a further data challenge. How assets deteriorate over time and how this affects the cost of maintenance and what risks they present is harder to judge over a longer period. Equally, the age of UK infrastructure also means that crucial information about assets is also often lost, difficult to retrieve, or expensive to recreate[3]. Therefore, gathering a complete picture of the asset that combines historic and current asset data into an effective, easy-to-access system can be challenging.

Even with the data that is available, there are also problems around ensuring data relevance, credibility, legitimacy, and effectiveness. Additionally, visualising this data is essential as assets become more intricate, with some assets becoming so complex and crowded within a small area that GIS alone struggles to visualise them. Therefore, even with a central asset data system, there can still be issues with being able to effectively use the available information.

2. **Parlikad, A.K. and Jafari, M. (2016). Challenges in infrastructure asset management.** IFAC-PapersOnLine, [online] 49(28), pp.185–190. Available at: https://www.sciencedirect.com/science/article/pii/S2405896316324569 [Accessed 30 Mar. 2022].

3. **Institution of Civil Engineers (2017). Intelligent Assets for Tomorrow's Infrastructure: Guiding Principles.** [online] ICE. Available at: https://myice.ice.org.uk/getattachment/knowledge-and-resources/best-practice/how-best-to-adapt-to-the-big-changes/ICE_Intelligent_Assets_for_Tomorrows_Infrastructure_Guiding_Principles.pdf.aspx [Accessed 30 Mar. 2022].

How smart asset management can help

Smart asset management is an ecosystem of digital and physical solutions that encompasses dynamic modelling, real-time visibility, connected assets, worker safety and data intelligence. Leveraging emerging technologies provides tools for industry collaboration and innovation, improved productivity and compliance, and, ultimately, the sustainable management of critical assets. Solutions that are smart, agile and interconnected, support us in delivering new, improved outcomes for our organisations, employees and communities.

Smart asset management goes hand-in-hand with smart assets, be they infrastructure or other equipment. According to the University of Cambridge's Centre for Smart Infrastructure and Construction, smart assets are a global opportunity worth £2trn-4.8trn to the infrastructure sector alone[4].
The aim is to help owners and operators get more out of the assets they have. Irrespective of the type of asset in question, adding digital enhancements to physical assets offers a way to drive better performance at a lower cost. The ownership of the data that smart assets generate and the ability to analyse it and use it to make informed decisions is the key to capitalising on this opportunity.

Benefits of smart asset management

As budgets become more constrained and resources scarcer, the only way to ensure the cost-effective maintenance of and enhanced service provision from existing assets is to gain more from the assets themselves. This means providing improved information to enable better decision-making, quicker and cheaper than with current methods.

Through data-driven planning, capacity, efficiency, reliability and resilience are all improved as an enhanced understanding of the asset performance is enabled. This way, the whole-life cost of assets can be determined, and unforeseen costs avoided with a robust asset management strategy.

In addition, better data visualisation with smart asset management shifts the asset information from static, textual datasets to dynamic, data-rich solutions with the application of 2D, 3D and 4D visualisation principles. This makes the data clearer and easier to understand, access, and share. Data accuracy and validation is supported in real-time, making it possible to manage any asset class in any location.

The challenges of data relevance, organisation, and security can all be overcome while supporting business objectives.

4. **Bowers, K., Buscher, V., Dentten, R., Edwards, M., England, J., Enzer, M., Parlikad, A. and Schooling, J. (n.d.). Getting more from strategic assets.** [online] Available at: https://www-smartinfrastructure.eng.cam.ac.uk/system/files/documents/the-smart-infrastructure-paper.pdf.

Technologies transforming asset management, operation and maintenance

Innovation is accelerating our progression towards truly smart assets.

These emerging technologies aren't necessarily new, however, they are at various stages of adoption and technological advancement, therefore they remain emergent. BIM, for example, has been around for decades, but there are still areas of the construction industry who have yet to adopt it.

As technologies become more commoditised, more of these innovations will become mainstream.

Building Information Modelling (BIM)

As we know it today has been developed since the late 70s but only achieved widespread popularity during the last 10 years with the first few dimensions, often referred to as multiple layers of data. Today, BIM is already at the tenth dimension, or layer, allowing data to be modelled on time, cost, sustainability and environmental properties, asset and facilities management, safety, and lean and industrialised construction.

In addition, combining this BIM data with asset data, 2D schematics and 3D models can produce powerful insights on individual assets, or across the entire asset portfolio. Visualising data from horizontal and vertical infrastructure enables easy navigation and interaction with complex structures for both asset management and maintenance activities. Often, other activities such as budget and contract management, job creation, reporting and assessments can be integrated as well, and the outputs easily shared with external service providers.

These platforms provide a seamless, single source of truth that is updated in real-time and easily accessible to all stakeholders, for better asset data management.

Digital twin

Digital twins enable the creation of a digital replica of the built environment but enhanced with data from sensors and other inputs.

Digital twins generally rely on information gathered by Internet of Things (IoT) sensors. These sensors can be positioned just about anywhere, as they are becoming smaller, smarter and mobile. They create connected assets allowing for accurate, real-time monitoring.

The power of combining technologies like these, is the facilitated asset optimisation and improved predictive and preventative maintenance capabilities. They provide a continuously updated record of performance data across many different areas, enabling adjustments and future planning to be carried out based on facts before there are any issues.

For example, digital twins and IoT sensors enable activities such as:

- Controlling energy usage
- Monitoring water meters
- Optimising utility networks
- Identifying high risk areas.

Real-time data provides insight into how the environment is being used and how it evolves over time. Leveraging connected asset data enables:

- Trends and patterns to be detected
- Supporting evidence-based decisions to minimise risk, maximise performance and improve utilisation.

Together, this provides essential data on asset performance, enabling physical assets to be managed and optimised, and ultimately leads to lower repair costs and longer asset lifecycles.

Extended reality

Extended reality (XR)

is a combination of the physical and digital worlds where visualisations are generated by software and wearables and allow the information to be easily understood and seen in context.

Through augmented, virtual or mixed reality, the user can step inside design plans before projects commence, walk through sites to support health and safety training, run simulations of complex processes, and perform remote site inspections. All of these activities allow the operator to gather data or perform maintenance without risk to themselves or the project. This ensures that any data that isn't collected autonomously is gathered with as few risks as possible.

Wearables can also be used by field operators carrying out asset maintenance activities.

Smart glasses, watches, boots, helmets and bodywear are designed to keep workers safe, healthy and productive.

Glasses enable field operators to display safety protocols, identify hazardous materials and areas, and interact with remote technicians as they guide the operator through complex tasks using visual aids.

Watches allow for handsfree communication, assist with contact tracing, and monitor health indicators and activity levels with alerts sent to authorised personnel.

Boots, helmets and bodywear can detect impacts, potential risks and harmful gases.

Exoskeletons provide field operators with support and strength, improving worker safety and efficiency whilst reducing body stress and fatigue.

For any assets that require fieldwork, wearables are an indispensable aid for improving worker safety and collecting additional asset information.

Artificial Intelligence (AI)

Artificial Intelligence (AI) has many uses for asset management, such as remote inspections, deterioration analysis, lifecycle optimisation, and predictive and preventative maintenance. It can help automate some of the decisions that need to be made regularly, such as ordering parts that require replacing or preparing analysis reports, reducing the manual time and effort required for operations and management. Another use is **generative design**, which automates and optimises design outputs by solving complex problems.

Generative design uses AI-driven software to generate a range of solutions that meet a set of constraints, using parameters such as manufacturing methods, cost and materials, performance and spatial requirements. For assets that require optimisation or upgrading, generative design can help accelerate this process. The software explores all possible variations including designs that are impossible to make with traditional manufacturing methods. Instead, assets and components are constructed using new additive manufacturing.

Additive manufacturing, otherwise known as 3D Printing. It can be used to build prototypes and full-scale assets and components using water and heat-resistant material. Additive manufacturing addresses supply chain issues and labour shortages, reduces cost, time and human errors, and has a positive impact on the environment by reducing waste from traditional manufacturing.

Robotics

Robotics can also help with asset management, especially with regards to maintenance. Autonomous rovers, drones and bots increase the efficiency of inspections and surveys, particularly in the face of labour shortages. Mechanical arms can automate highly repetitive and complex tasks, and semi-autonomous robots, or co-bots, allow workers to perform dangerous activities safely. As automation continues to deliver efficiencies and increased worker safety, robotics are becoming more common-place in the field for asset management, operation and maintenance activities.

Innovative technologies

are changing the world we live and operate in.

As the adoption of emerging technologies increases, the need for smart asset management will continue to grow. The world we live and operate in today is being changed by Innovative technologies. Digital advancements are making it possible to build resiliency and improve both data intelligence and strategic planning.

AS A RESULT

- Worker safety is enhanced
- Assets are sustainably managed
- Risk is reduced
- Profit margins are protected

Overall, utilising these emerging technologies is essential to remain competitive in the digitalised world and employing smart asset management helps organisations maximise the return on these investments and achieve sustainable outcomes.