Leading Sustainable Innovation

A roadmap for technical environments

Jo North

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"In a world where sustainability is no longer optional, this is a vital resource for forward-thinking leaders."
Lucy Armstrong, CEO, The Alchemists, and Chair, Port of Tyne

"This book is a breakthrough. Jo North provides accessible, smart, practical and structured advice."
Joanna Berry, Associate Dean for Engagement, Durham University Business School

"A brilliantly well-researched and practical step-by-step guide on how to innovate whilst holding true to your values."
Heidi Mottram CBE, CEO, Northumbrian Water Group

"This will be an invaluable guide for anyone working in infrastructure, construction or the wider industry who is navigating the challenges of leading sustainable innovation."
Julia Prescot, Co-Founder, Meridiam, and Deputy Chair, National Infrastructure Commission

"A must-read for anyone passionate about merging innovation with environmental and economic responsibility."
Amanda Selvaratnam, Associate Director of Research and Enterprise and Head of Enterprise Services, University of York

Leading Sustainable Innovation shows how to deliver innovation within technical environments. It is tailored to support innovation leaders and managers in fields such as transport, engineering, infrastructure, energy, utilities and science.

This book offers practical methodologies, tools, frameworks and actionable steps that readers can implement to create lasting sustainable change for their projects and programmes. Through following a step-by-step process, readers will craft a comprehensive roadmap for sustainable innovation aligned with the United Nations Sustainable Development Goals.

Leading Sustainable Innovation examines multiple drivers of sustainable innovation, such as innovation strategies, state-of-the-art technologies, circular solutions and organizational factors necessary for success. It provides guidance on building a sustainable innovation culture and features real-world global examples and case studies such as Microsoft Sustainable Datacenters (global), Sellafield nuclear power station decommissioning (UK), Wunsiedel (Germany), Clean Path (New York), Roads and Transport Authority (Dubai), Agriphotovoltaic Assets (China) and Equinor (international), enabling readers to learn valuable lessons.

Jo North is an expert on strategic sustainable innovation within complex technical industries, with experience spanning the transport, manufacturing, engineering, infrastructure, energy, utilities, nuclear and oil and gas sectors. She is the Founder and CEO of The Big Bang Partnership Ltd and leads the UK's inaugural Maritime Innovation Hub. North is also an Associate Lecturer in Business Innovation and Creativity at the University of York.

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Chapter 6 – Levering Technology and Data for Sustainable Innovation

Data and technology in sustainable innovation projects

Data without people and supporting technology to access, analyse and use it is an unexploited asset. And with the availability of so much data, from such a huge diversity of sources, there is much more volume than even the brainiest of data scientists can be expected to handle successfully. We need technology to help us automate wherever possible the massive task of collecting, storing, processing, modelling and presenting the data to us in ways that we can understand, interrogate and use for practical decision-making. Here we offer the headlines of just a few of the technology approaches and tools for leveraging data for significant sustainable innovation programmes and projects.

Collaborative innovation

With so much data, complexity and diverse stakeholder interests, sustainable innovation project teams, their partners, customers and supply chain need to collaborate more than ever before, as we've seen in the example of the Maritime Data Cluster. We will explore how to achieve successful collaboration later in the book, but at this point it is important to highlight that technology, when used well, creates huge potential for information sharing and collaborative innovation.

Cloud-based collaboration tools break down geographical barriers, allowing for a seamless flow of information and ideas. Real-time data sharing and communication on cloud platforms mean that innovative solutions can be developed and iterated quickly. There are many options for collaborative workspaces for multidisciplinary teams to brainstorm, model and simulate different scenarios for sustainable innovation projects. They enhance transparency, allowing all stakeholders, from designers, architects and engineers to clients and contractors, to access project data. Additionally, these platforms can integrate stakeholder feedback effectively, ensuring that the project evolves in a way that serves the community's needs while also achieving sustainability goals.

Big data

Big data encompasses the vast data sets that are too large and complex for traditional data-processing software but which, when effectively analysed, can reveal patterns, trends and associations. It is often described using the five Vs, said to make up big data's core characteristics: velocity, volume, value, variety and veracity.

The United Nations reports that the quantity of data worldwide is growing at an ever-accelerating rate. In 2020, 64.2 zettabytes of data were created, a 314 per cent increase from 2015. It says: 'A large share of this output is "data exhaust", or passively collected data deriving from everyday interactions with digital products or services, including mobile phones, credit cards, and social media.' The United Nations also states that the proliferation of data is being driven by the widespread collection capabilities of cost-effective and ubiquitous information-sensing mobile devices, along with a global information storage capacity that has been on a doubling trend approximately every 40 months since the 1980s.[13]

For organizations, big data is a strategic asset that, when leveraged with advanced analytics, can provide insights into sustainability practices, enhance operational efficiencies and promote innovation. It allows leaders to make more informed decisions that are based on a balance of evidence and intuition.

Intelligent Asset Management (IAM)

Intelligent Asset Management (IAM) is the integration of digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics and cloud computing, into the management of physical assets. It aims to optimize the performance, efficiency and lifecycle of assets, while minimizing costs and environmental impact.

The key features of IAM are:

- **Real-time monitoring**: Using sensors and IoT devices to continuously monitor asset conditions and performance.
- **Predictive maintenance**: AI and data analytics are used to predict the optimum time for maintenance, preventing breakdowns and extending asset life.
- **Resource optimization and environmental impact**: Optimizing the use of resources such as energy, materials and labour, based on data-driven insights.
- **Lifecycle management**: Managing the entire asset lifecycle from acquisition, operation and maintenance to disposal or recycling.
- **Compliance and reporting**: IAM systems can help organizations meet sustainability regulations and standards by providing accurate data for reporting and compliance purposes.
- **Cost reduction**: While reducing environmental impact, IAM also leads to cost savings by improving efficiency, reducing downtime and extending asset lifespans.

Digital twins

A digital twin is a dynamic digital representation of a physical asset, process or system. It provides a real-time, holistic view of an asset's performance, maintenance needs and operational efficiency throughout its lifecycle. Digital twins are transformative tools that enable better planning, design, delivery and operation, with the aim to optimize efficiency, minimize waste and enhance safety. By mirroring real-world conditions, digital twins enable scenario planning and problem-solving in a virtual environment, reducing risks and costs associated with physical trials and errors. They rely on big data to accurately reflect the real-world condition of assets and use IAM principles to manage these assets effectively throughout their lifecycle.

Digital twins are typically built using the following key elements: sensors for performance data collection; the data itself, from data and other relevant sources; integration of physical data into the virtual environment; algorithms, models, analytics and visualization; and automated or manual 'actuators', i.e. tools that adjust and make changes as required. They run using several advanced tech tools: IoT; cloud computing; augmented, mixed and virtual reality; and AI.

For leaders of sustainable innovation looking to implement digital twins in projects, it is essential to focus on establishing a robust data infrastructure, ensuring interoperability between systems and maintaining data security and privacy. Collaboration among stakeholders and adherence to industry standards and best practices are crucial for the successful deployment of digital twins.

As infrastructure continues to digitalize, digital twins are increasingly becoming a key element of intelligent asset management capable of dealing with the complexity of sustainable innovation projects.

The Alan Turing Institute asserts that digital twins 'represent one of the most powerful tools' for helping to achieve net zero:

> We envision a wide range of digital twins of both natural and built environments, allowing researchers to optimise systems and policies with the aim of minimising greenhouse gas emissions. For example, a digital

twin of an energy system could allow decision makers to explore different policies around renewable energy generation or support schemes for home energy upgrades.[1]

The market for digital twins is growing fast. Research published in early 2023 by FACT.MR shows that it's already worth more than $5 billion globally and is expected to be worth $95 billion by 2033, growing at a compound annual growth rate of 34 per cent.[2]

Building Information Modelling (BIM)

Building Information Modelling (BIM) is a comprehensive process that involves the generation and management of digital representations of physical and functional characteristics of places. BIM models are files that can be extracted, exchanged or networked to support decision-making regarding a built asset. The approach is used to plan, design, construct, operate and maintain diverse physical infrastructures, such as water, waste, electricity, gas, communication utilities, roads, bridges, ports, tunnels and more.

Both BIM and digital twins are being used more and more for sustainable innovation in construction, enabling smarter project management, reducing waste and improving the efficiency and longevity of buildings. While BIM lays the foundation during the creation phase, digital twins continue to add value, ensuring the asset sustainability and adaptability throughout its lifecycle.

BIM has transformed the management and visualization of building data. It uses cloud-based models to compile multidimensional data, creating an intelligent model from planning to operation and maintenance. Both BIM and digital twins can be used in the architecture, engineering, construction and other industries, for different purposes:

- BIM is a comprehensive process that involves the generation and management of digital representations of the physical and functional characteristics of places. It captures a detailed digital description of every facet of the built asset, playing an important role in the project lifecycle from initial planning to final construction. It allows for advanced 3D modelling and extensive data management and facilitates collaboration between architects, engineers, contractors and other stakeholders, primarily during the planning and construction stages.
- Digital twins provide a dynamic and up-to-date digital reflection of a physical asset. Unlike BIM, their use is not limited to buildings but extends to a diverse range of assets and systems that can be represented in a digital form. Digital twins are useful for monitoring the health and performance of structures, allowing for detailed diagnosis and the simulation of real-world behaviours and conditions. They harness real-time data from IoT devices and sensors, driving predictive analytics to forecast and scenario plan for future conditions. Digital twins are often leveraged throughout the entire lifespan of an asset or system to support ongoing maintenance and management.

[1] Conner, A, Hosking, S, Lloyd, J, Rao, A, Shaddick, G and Sharan, M (2023) Tackling climate change with data science and AI, Zenodo, https://doi.org/ 10.5281/zenodo.7712968 (archived at https://perma.cc/NJ6R-6MK4)
[2] Fact.MR (2023) Digital twin market size worth US$ 95 billion by 2033 at of CAGR 34.3%: Fact.MR Research, www.globenewswire.com/ news-release/2023/01/18/2591244/0/en/Digital-Twin-Market-Size-worth- US-95-Billion-by-2033-at-of-CAGR-34-3-Fact-MR-Research.html (archived at https://perma.cc/VK2J-SKLZ)