RISING ABOVE THE NOISE:

What Artificial Intelligence means for the built office environment.

CONTENTS

FOREWORD

At the heart of ISS lies a steadfast belief: People make Places. This is not merely a strapline, but the cornerstone upon which our reputation is built. It's the vibrant, dedicated, and innovative minds at ISS that drive us forward, shaping not just our workplaces but the future of facility services.

As we navigate the evolving landscapes of our industry, understanding how emerging technologies can enhance and empower our people to deliver exceptional experiences will become increasingly central to our progress and pursuit of excellence.

The publication of this white paper comes at a significant point for ISS as we explore emerging technologies – Artificial Intelligence (AI) and Machine Learning (ML) – to achieve our mission. Authored by eminent AI scientist Inma Martinez, this document thoughtfully examines the implications of AI in workspace environments, illustrating how these technologies serve as a potent enabler in amplifying our human potential.

The chapters within examine key components of a workspace – energy, building sustainability, workplace experience, talent attraction and retention, and information security – each culminating with key takeaways as a roadmap for intertwining AI with core operations. From fostering smart energy management to nurturing a culture of inclusivity and security, these insights underscore the instrumental role of AI in augmenting ISS's human-centric ethos.

The exploration of AI and ML, especially within food and energy sectors, is a testament to our ambition of harmonising human ingenuity with technological advancements.

It's an exciting journey, and one that promises not only enhanced operational efficacy but also a greater impact on the communities and clients we serve.

With many prominent voices endorsing AI as a 'force for good', the discourse is escalating and pivoting towards a positive, progressive and pragmatic narrative. A forecast by PwC anticipates a 10.5% surge in the UK's GDP by 2030 due to AI, further underscoring the economic imperative of this technological marvel.

In conclusion, this white paper invites our clients, partners and stakeholders to join us in a future where our people – bolstered by technology – continue to make places that connect, inspire, and thrive.

LEANNE LYNCH
CIO, ISS UK & IRELAND

ABOUT THE AUTHOR

Inma Martinez is a technology pioneer, AI scientist and advisor to businesses and governments, advocating for the digital economy as a force for progress and societal welfare.

Combining her previous careers in investment banking and telecommunications alongside technology entrepreneurship, she is recognised worldwide as one of the leading entrepreneurs who worked with teams at Cambridge University and Trinity College Dublin to pioneer the first real-time AI recommendation system of the mobile internet. Throughout the 2000s, Inma continued working in technology innovation, creating emerging digital technologies like mobile music and video streaming, the connected car and smart living. Her unique experience has allowed her to become one of the most sought-after experts in forecasting digital disruptions and revealing the enormous potential of AI and other transformative technologies.

As a government advisor, Inma currently serves as Chair of the Multi-stakeholder Expert Group and Co-Chair of the Steering Committee at the Global Partnership on Artificial Intelligence (GPAI), the G7 and G20 global agency for development and cooperation on AI. She joined the GPAI as a government-nominated expert on innovation and commercialisation of AI and also leads the 'AI in Agriculture' project. Inma has served in the United Kingdom for the Trade & Investment Agency; the Innovation Fund of the Department of Sport, Media and Culture; the All-Party Parliamentary Group on AI. For the Spanish government, she is currently a member of the AI Council Advisory Board (State Secretariat for AI) at Ministry of Economic Affairs and Digital Transformation.

Since 2001, Inma has provided expert testimony and sector strategies on Big Data and AI at the European Commission, contributing to numerous strategies and policies shaping the digital future of the single market; at the United Nations Industrial Development Organisation (UNIDO), highlighting the implications of the 4IR for developing countries; became a collaborator on UNESCO's initiative to make AI inclusive of intercultural input; and worked on the European Space Agency's Human and Robotic Exploration and Ariane Cities programmes.

Inma is a guest lecturer at Imperial College London Business School (UK) and directs the Master in AI programme at the University of Loyola (Spain), where she is also a member of the university's advisory council. She has been a key figure in European knowledge-transfer efforts and has mentored on technological innovation at top venture-focused acceleration programmes.

She has authored two books, The Future of the Automotive Industry (2021) and The Fifth Industrial Revolution: How Space Commercialisation will Derive the Biggest Industrial Expansion of the 21st Century (2019). She has also collaborated on numerous white papers about cloud and edge computing, as well as other innovations in telecommunications.

Both Fortune and Time magazines have described Inma as one of Europe's top talents in social engagement through technology. Fast Company labelled her a 'fire starter', while the Financial Times and The Economist have counted on her expertise at their conferences. She was voted 'Best contributor to the formation of strategy' at Bloomberg Businessweek's 'European Leadership Forum: Charting the Economic Future of Europe'.

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INTRODUCTION

Ever since the Bronze Age (around 2000 BC), humanity has collected data and kept records, listed terms of trade, registered lands, calculated distances, affirmed scientific discoveries and undertook other fact-checking endeavour. Not only to understand reality but, also, to make sense of it, plan and exert superiority over others less prepared. Cognition – our ability to know and act upon data – is the final frontier; not just 'IQ' intelligence, but the complete understanding of everything that is, and anything that may be.

For some time, when information and data has reached an insurmountable scale and complexity, early forms of AI have been developed to teach computational systems how to perform tasks humans cannot. For example, in deciphering the Enigma machine, an encoding device developed in the 1920s to protect commercial, diplomatic, and military communications; those who attempted to break its source realised that a 'Type A' brute force intelligence had to be deployed – a computational intelligence infinitely superior to the human brain's biological ability. This led to the development of computers, the birth of statistics, systems thinking, and scenario planning.

Scenario planning achieved its most renowned triumph when Shell Oil, an early developer of unified machine planning, was the only oil company that correctly predicted the 1973-1974 OPEC oil embargo, sparing themselves the misery sustained by their US competitors.

AI's superpowers have been felt most strongly when its products and services have been deployed across sectors and industry. Indeed, since the 1970s, computational intelligence has brought businesses an unparalleled ability to predict events, create optimisation models, automate systems, detect failures, reveal patterns, and deliver insights never before attained. AI is therefore a force endowed with an ever-expanding versatility: fuelled by the scientists who create and train it; enabled by the mathematicians who embed into its cognition all the enormous problem-solving potential that algorithms can bring; and pioneered by the businesses that dare to build competitive assets based on service-led, human-centric and best-of-kind features.

The built office environment is about to enter an exponential era of AI-driven products and services that will transform how we address the challenges ahead:

- Sustainability; a top value indicator for both investors and consumers
- Organisational growth within ergonomic spaces – how to revalorise physical work environments as contexts of purpose, creativity and social cohesion
- Responsive, adaptable and scalable integrated services – flexible and interconnected service hubs that address both business and people requirements.

And perhaps most critically, a decentralised data architecture that allows for further optimisations.

For every complex task ahead – preservation and generation of new energy sources; physical and cyber security, sustainability (in both decarbonisation and efficient use of resources); and transformation of the workplace experience into a test-bed for innovation and social equity, as well as a competitive asset to retain and attract human capital talent – AI is creating solutions and in-roads that will dramatically change how we do business now and how we plan for the future.

Each of the following chapters outline attainable solutions, articulate their effects on the built office environment, and examine the potential impacts and opportunities for people and on day-to-day operations and innovation pathways.

CHAPTER 1:

ENERGY

By 2050, the global population is expected to reach 10 billion, mostly dwelling in large megacities. Blue Origin, Jeff Bezos' space transport company, has calculated that, based on the simple compounding of average watts that each person consumes in developed economies (currently 10,500 per year, but this is expected to double every 25 years), Earth-based energy resources will be exhausted in about 200 years.

If we add to this the energy needs of businesses, as industry accelerates exponentially towards digitisation (smartification of devices, the rise of supercomputing and generative AI training, which is already depleting the current grid), the projected 200 years may be even less – perhaps as little as 100 years.

The current energy picture shows an enormous dependence on the environment, around USD$58 trillion, or half of the world's Gross Domestic Product (GDP). This has not only had a disastrous effect on global wildlife decline (69% since 1970), but also in land degradation, resulting in a 10% loss of the world's potential economic output. In summary, bad energy management and lack of additional energy resources is costing us both economic progress, and the chance to live in a world that self-regulates its own climate and allows for all of humanity to be fed and breathe clean air. Energy management is therefore an urgent matter for businesses seeking not only to optimise and preserve their energy resources, but also to create circular economies of self-generation and re-utilisation.

When one thinks of energy in the built environment, the need to assess present and future energy requirements goes beyond fulfilling the United Nations' Sustainable Development Goals (SDGs). For all organisations, it is essential to minimise grid usage and invest in renewable energy generation infrastructure. This includes identifying what energy sources are appropriate/available for their business units; whether that be grid energy only, renewable energy, or alternative resources such as stored energy, building use must operationally plan for all three. In certain scenarios, such as on-premise data infrastructure, if the necessary megawatt allocation cannot be awarded to an organisation's commercial building, aspects of their operations may need to be fully outsourced. This complex energy management challenge means that many organisations will no longer be able to use historic data, such as prefixed setpoints in HVAC systems, to manage their energy needs. Instead, AI systems will be needed to manage energy demand in real-time.

Over the next five years, prioritising needs, optimising management systems, and, where appropriate, entering the energy trading market will define the energy landscape within the built environment sector.

Current challenges

Alongside decarbonisation efforts, a combination of approaches must be explored when considering the energy paradigm. Renewable energy is at the centre of this transformation, and AI plays a core role in its management and optimisation. In today's hyper-competitive landscape, an organisation's growth and success will soon be tied to its ability to generate its own energy, preserve that energy via optimisation processes and, if they have excess capacity to sell back to the grid supplier, potentially enter the energy trading and grid interaction market. For decades, Energy has always been considered a costly operational expense. Today, for organisations that can offset their energy use with energy generation, energy costs will be dramatically reduced, in some instances becoming a zero-cost liability. For organisations generating an energy surplus, it could even become a net asset.

This objective, which, in principle, seems straightforward – for example, installing photovoltaic panels on building roofs is now affordable and even subsidised by some governments – starts to get complicated when we consider deployment of the other two steps in the process, preservation & optimisation, and if we want to embrace the opportunity, efficient energy trading.

The current energy picture shows an enormous dependence on nature

US$58 trillion

69%

Global wildlife decline since 1970

AI-driven energy management

AI, through data analytics, machine learning and the automation of energy systems, presents a wide portfolio of energy management solutions for commercial buildings. These include:

- Data collection and monitoring which analyses and recognises patterns in energy consumption
- Predictive analytics – trained on historical data and external factors, such as weather forecasts and occupancy schedules – that anticipate how different weather conditions might impact heating or cooling needs
- Optimisation algorithms that reduce energy waste by orchestrating ideal temperature and lighting levels.

What differentiates current solutions from those that will soon emerge as stand-alone energy management products is the type of data that feeds them. Real-world data (RWD), raw data collected from various sources, and real-world evidence (RWE), conclusive data derived from analysing RWD and confirming the effects of systems in the real contexts, are far more accurate than previously available data and, as such, these will unlock the full power of AI.

When considering building energy management, RWD and RWE are perfectly suited to 'the new normal' where factors like weather patterns (which now change year-on-year) and hybrid working (which makes building occupancy levels unpredictable) require decisions that are based on 'real-world' data. RWD and RWE also eliminate unacknowledged/unknown bias which was latent in some historical data – for example, all human thermal data used in industry being based only on the male body, a factor that has only been recently challenged by data analysts.

Today, AI systems can power new building management operations based on RWE:

- Occupancy levels derived from wearable sensors
- Dynamic adjustments and controls that are adaptive to actual occupancy
- Adjusting natural light (whenever possible) via domotics – environmental sensors, automated blinds and shades
- Other smart devices delivering data to building management systems.

The energy portfolio

Commercial and residential buildings account for a significant portion of global energy consumption. This trend poses challenges regarding energy supply, grid stability, and environmental sustainability. As we install renewable energy infrastructure in the built environment, AI will help achieve more efficient use of energy resources and reduce carbon emissions.

The new energy sources that a building must manage include generation, storage, and grid supply. Automation rankings created by AI can decide which type of energy is more cost-effective to use at any time of the day and for which specific activities. Meaning, each business can create a hierarchy of primary energy supply needs and the AI-enabled system will prioritise and optimise what type of energy must be supplied to which resource, both in business-as-usual mode (for example, storing photovoltaic energy in batteries in the summer months, which have longer daytime hours than winter months, and using these to power low-demand, non-critical resources) or providing on-demand energy as a backup source when the grid fails. Enabling this

requires the installation of sub-metering infrastructure – installing additional meters within a building to measure the consumption of utilities for specific individual units, areas, or equipment within that property. Current sub-metering systems often come with advanced features such as remote monitoring and data collection, allowing property owners or managers to access consumption data remotely and in real-time.

AI for microgrid management

The built environment can also deploy microgrids as a form of renewable energy management. A microgrid is a localised and self-contained energy system that can generate, distribute, and manage electricity independently or in conjunction with the main grid. It consists of various distributed energy resources (DERs) such as renewable energy sources (solar panels, wind turbines), energy storage systems (batteries), and traditional generators (diesel, natural gas), along with advanced control and management systems.

The key feature of a microgrid is its ability to operate autonomously or in 'island mode', disconnected from the main electrical grid during disruptions or emergencies. AI can enable smart grid management by monitoring and controlling the flow of electricity in real time. By integrating renewable energy sources, energy storage systems, and demand response mechanisms, AI can help balance supply and demand, maximise renewable energy utilisation, and minimise reliance on the external supplier grid.

In cases where microgrids are interconnected with the main power grid, AI can optimise energy trading decisions. By analysing real-time energy prices, grid constraints, and microgrid capabilities, AI algorithms can determine the most cost-effective and carbon-efficient approach to energy exchange with the main grid. This enables the microgrid to make informed decisions on when to import or export energy, contributing to grid stability and decarbonisation efforts.

AI solutions for energy efficiency

If we want to improve both comfort and energy efficiency autonomously and in real time, we must consider an infrastructure that allows for the interoperability of the integrated system of sensors (from wearable sensors to infrared sensors) fitted on people and spaces, and actuators (HVAC system setpoints, ceiling fans) that will operate under a governing central intelligent system. The sooner organisations are able to record and analyse energy waste from their operations, the better positioned they will be to address the sustainability challenges and the need to optimise energy management.

AI's true power is to orchestrate the interactions of intelligence entities – including automated HVACs, environmental data via thermostats, sensors and performance data (what we expect to be the efficient functioning of each) – to correctly deploy problem-solving abilities in real time, executing decision-making capabilities, and learning from unexpected circumstances. For this, an AI system uses search algorithms (exploring and pursuing multiple routes to achieve a task, understanding which routes yield better success most efficiently); logic inference (creating rational thought to reach rational decisions understanding their contexts); and machine learning (AI's programming language based on mathematical algorithms to understand complex data).

Applications and requirements of AI for thermal comfort in buildings

The fact that HVAC systems account for up to 10-20 per cent of the total energy consumed in developed countries (Pérez-Lombard et al., 2008) makes thermal comfort-driven HVAC operations an opportunity not only for energy savings but also for productivity and wellbeing improvements. Currently, there is a shift towards dynamic heating, ventilation, and air conditioning (HVAC) schedules that use actual occupancy on-demand and real-time weather variables, allowing systems adaptability and enabling spaces to better cope with residual heat.

AI algorithms can be used to analyse Internal Heat Gains (IHG) data, which is a major component of the total building cooling load, especially in the office building environment. This includes, thermal modelling which handles structured data from lights (on or off) and other electrical equipment of all kinds (based on their known wattage), as well as analysing the heat generated by people and process loads, where IHG will depend on the level and variety of activities. Analysing these, sometimes very large, data sets in combination, is essential to accurately modelling energy efficiency, and AI is ideal for this.

When it comes to the impact of people on IHG, energy efficiency modelling requires that the level of human activity is also taken into consideration; as it happens, concurrently and in every space of a building. This is complex challenge; a person seated at a theatre chair is at rest and the heat gain will be lower than if the same person was seated in an office doing light work, and even moderate work can cause an increase of 50 British Thermal Units (BTU) gain.

Modelling in environments where there are lots of people undertaking a variety of different activities is particularly complex: in a retail environment, a single person standing or

walking within a store can increase heat levels by an additional 100 BTU. This means, the slightest change in the activity of the individuals in the store will affect the kilograms of refrigeration needed – the size of the store, whether it has multiple floors, and the variety of human activity within, are all factors that increase the possible margin for error in energy calculations. In these multifaceted environments, highly efficient energy management requires real-time processing and analysis of copious amounts of constantly changing data and this can only be achieved by AI algorithms.

In acknowledgement of both the complexity of the challenge and the huge energy cost efficiencies that can be realised, the next two years will see the emergence of off-the-shelf AI-based energy management solutions that will dramatically improve the function of electrical devices.

AI solutions for energy trading

With the emergence of electric vehicles (EV), vehicle-to-grid (V2G) charging models are creating new business models in the energy market. EV owners can now charge energy back to the grid from their EV batteries via bi-directional charging units and be financially compensated for it – buildings can do the same.

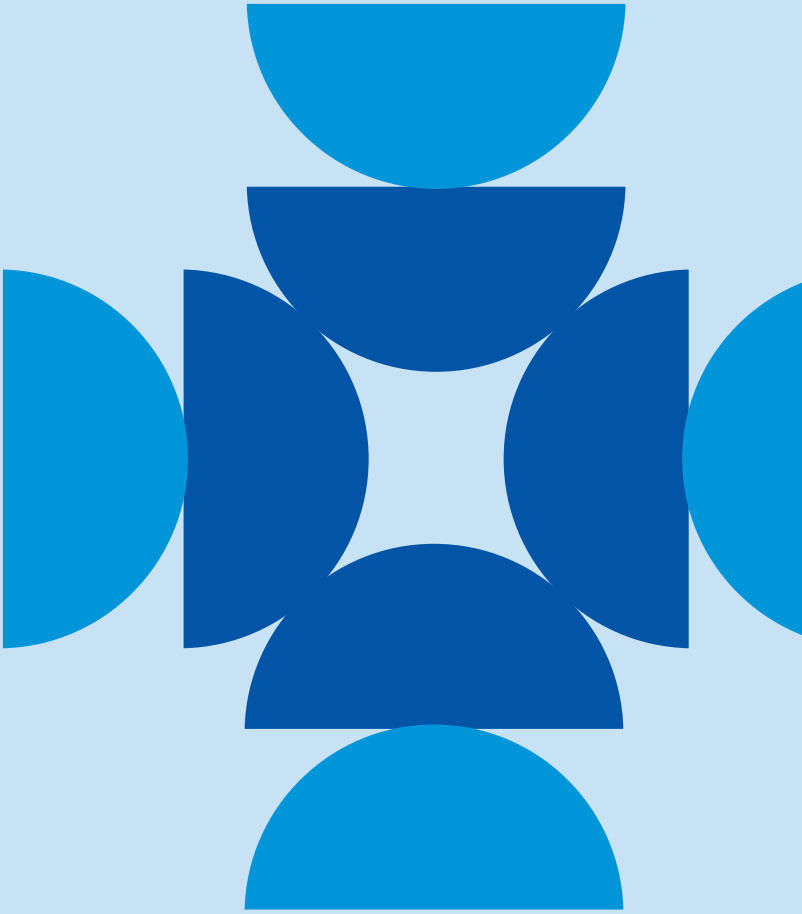
Feeding excess energy capacity back to the electrical grid is not a new concept, but AI is a key tool in efficiently managing the correct time to sell back to the grid, and at what volume. This uses net metering or grid-tied solar systems, and allows buildings to become both consumers and producers of electricity. Excess electricity is fed back to the grid via a two-way meter and the building owner receives a credit from the electricity supplier to offset their electricity consumption. The grid interaction between supplier and building owner creates a seamless exchange that, in some markets where renewable energy is being encouraged by local governments, energy regulators have opened to energy trading as a service (EaS).

KEY TAKE-AWAYS

1 Microgrids not only present an effective approach to building energy demand management, but also as a step towards smart use of energy resources and better decarbonisation strategies.

2 Climate change is exerting new challenges on the construction environment and the thermal assurance of buildings, compelling the industry to train AI-driven HVAC with real-time, not historical, data.

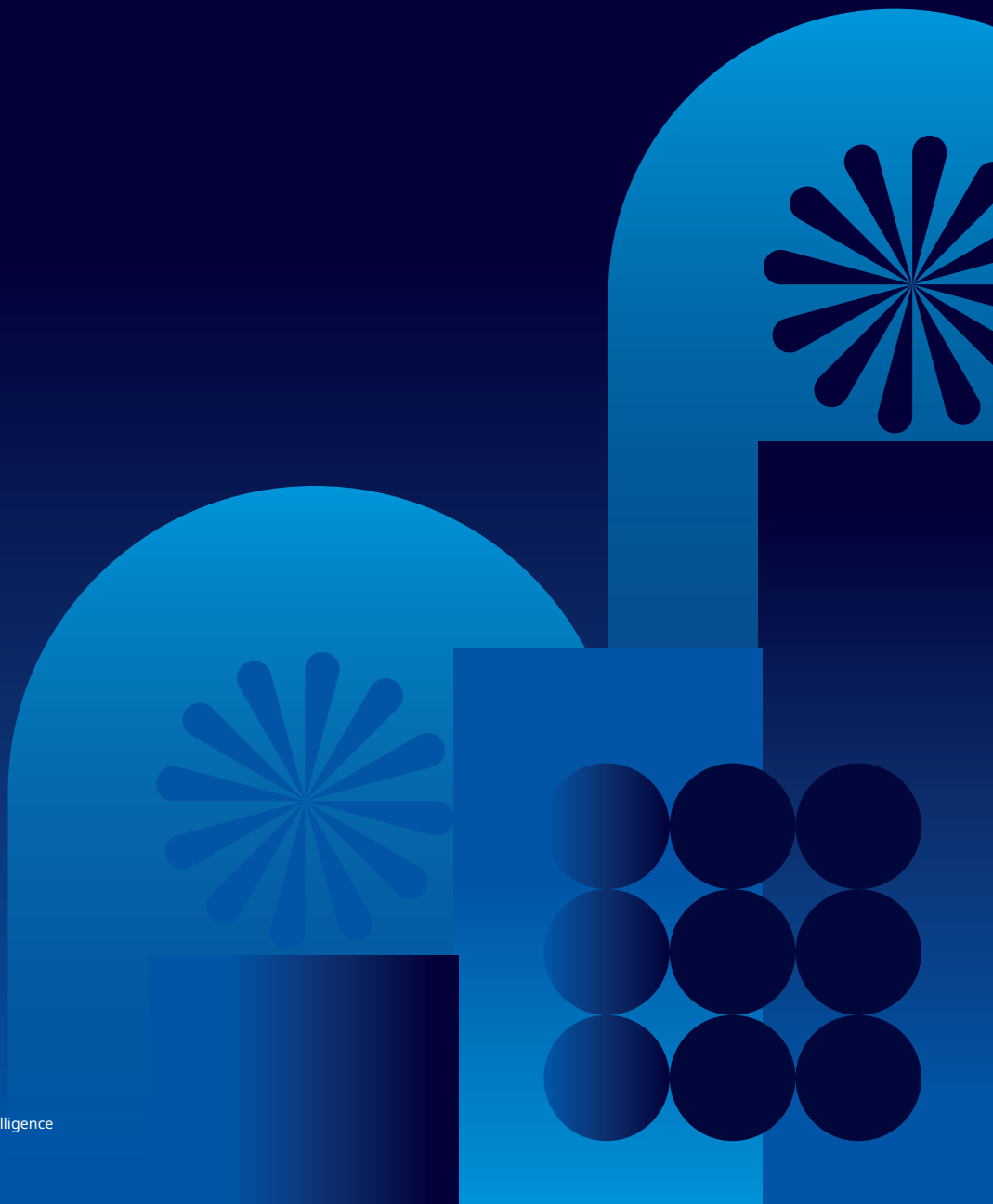
3 Energy trading is an emerging practice that offers opportunities for cost offsetting, and it should be explored by organisations with large real estate portfolios and global operations.



CHAPTER 2:

BUILDING SUSTAINABILITY

Buildings are no longer only inert physical structures. Some are now like living organisms, interacting with their occupants, the weather and attempting to integrate with their local natural ecosystem. This enormous transformation is being assisted by AI, informing the building lifecycle from conception and design, enabling accurate calculation of build costs, optimising construction processes and creating a roadmap for future operational management.



Today, sustainability in the construction environment is one of the most important focus areas for achieving decarbonisation. Clients and project promoters have brought forth specific demands to create and operate processes that prioritise resource efficiency and ecological design. Guided by sustainability principles, they treat buildings as living organisms that have a lifecycle, from design and planning to construction and occupation, integrating environmental considerations seamlessly. This roadmap has environmental protection at its core; it deploys ecological practices aimed at reducing consumption and reuse of resources, use of recyclable resources, elimination of toxic waste, and application of lifecycle costing. It also emphasises the use of durable construction materials that are resistant to wear and tear, adaptable to weather/the passing of time, and biodegradable.

Compared to retrofitting and repurposing old building stock, new buildings provide the opportunity to adopt sustainable practices from inception. Cement is out, and in come new low-impact recycled solutions like blown paper insulation or materials repurposed from other building sites. In addition, the building design has an enormous impact on its sustainability: Bauhaus is back, and with it, durable modular designs which are helping to decrease construction time and minimise wasted materials, many of which can be continually reused and recycled – think shipping containers repurposed as reusable living spaces. Increased sustainability targets can also be achieved if the construction waste – roofing, cardboard, glass, drywall, metal, insulation – is recycled.

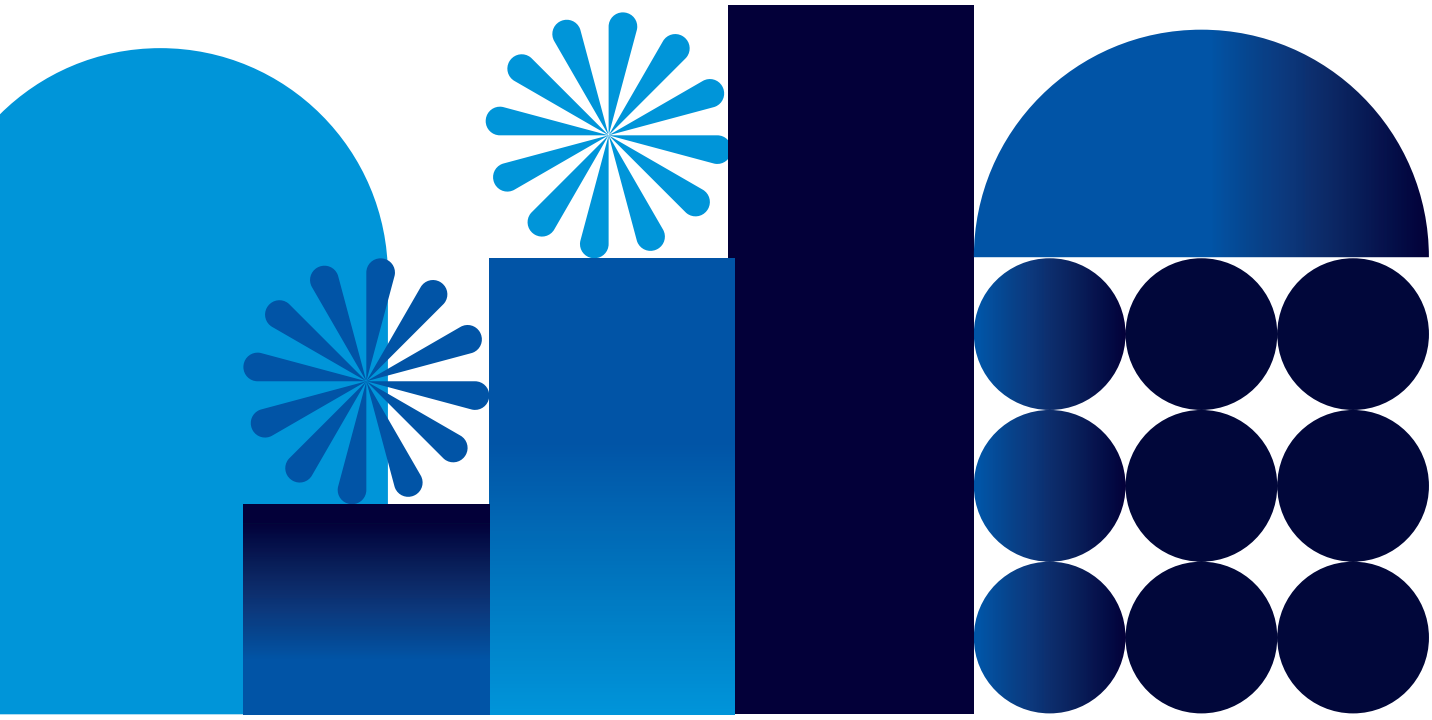
Alongside new build, organisations seeking to meet stretching net-zero commitments are also implementing carbon-reduction strategies that make their existing building stock more sustainable. In some ways the approach must be more nuanced than in new build. For example, when considering replacement of an existing inefficient HVAC system, alongside the anticipated energy savings, the embodied carbon cost of the new asset must be considered. Today, when planning building retrofit/repurposing, organisations are using AI-enabled predictive modelling to both confirm the efficacy of carbon reduction interventions and provide the objective precise data needed to underpin capital investment planning/approval.

However, the scale and complexity of challenge remains daunting. AI has the ability to rapidly interpret real-time and historical data at scale, model scenarios, plan logistics, predict outcomes and even create – fully harnessing these capabilities will be key to helping organisations mitigate the environmental impact of their buildings and workplaces.

Current challenges

Today, achieving zero impact on the planet is virtually impossible for most organisations. However, this worthwhile stretching ambition may become achievable if vanguard technologies like AI, are deployed to optimise the location and use of buildings. Through its adoption, factors like the office space required to enable/deliver optimal occupancy levels can become be embedded into energy performance/requirements forecasts (enabling real-time adjustments to heating, cooling, and lighting to ensure optimal energy efficiency and cost savings) and questions like 'Are football pitch-sized trading floors or vast open plan offices in Silicon Valley energy efficient?' can be objectively and definitively answered.

Alongside the functional operational aspects of building interior optimisation, AI can also be used to calibrate many 'human' variables, including employees' ability to perform in indoor conditions; this insight can be used deliver environments that have been empirically designed to keep occupants energised, motivated, positive, focused, and creative.



AI digital twins in the design phases

Using AI-enhanced Building Information Modelling (BIM) systems, highly detailed 3D models of the building design allow for precise evaluation and optimisation of the integrated architectural and engineering designs. The digital twin of the building – that is, the digital design created by the AI simulation programme – enables complex calculations to calibrate and test any minimal improvements, for example, in achieving natural light targets, the exact amount of insulation required, as well as other design considerations that reduce the use of natural resources.

The use of digital twins to model the performance of materials has been proven in other sectors. For example, the manufacturing and automotive industries have used digital twins to produce mechanical parts and vehicles that have been stress-tested against crash; testing the materials on thermal and physical forces much beyond what a built prototype could demonstrate in a wind tunnel or subjected to in the real world. In the built environment, the use of design simulators allows for the selection of eco-friendly materials and their digital testing for durability and environmental impact without the need to build physical prototypes. This AI-enhanced modelling allows for better decision-making and opens the door to significant cost-saving strategies.

AI cost estimation modelling

Budgetary constraints in construction are often cited as the reason why construction projects cannot achieve sustainability targets, with some companies claiming that 'building green is costly at the outset'. However, used to its full capacity, AI can optimise construction costs by analysing historical cost data and project specifications. In new build, retrofit and building repurposing, it can be trained to calculate and predict project costs with degrees of accuracy unachievable with traditional planning methodologies, for example:

- AI prediction models can take into account any cost eventualities, including typical project cost overruns, enabling more accurate scenario planning
- AI can model all types of costs within the lifecycle of a building, offering prioritisation options and enabling re-evaluation of planning objectives through predictive analytics that can anticipate and mitigate potential cost overruns – this enables both project managers and financial planners to assess which issues need escalation/re-calculation.

AI generators for indoor energy optimisation

AI generators use neural networks, a learning method which teaches the programme patterns, features, and relationships within data – alongside data analysis, they can be used to generate images and visuals. For example, in architecture, realistic 3D models – complete with textures, lighting, and even virtual landscapes – allow for the visualisation of real building data such as wind patterns, solar radiation, and geographical orientation of a building on an urban plan, helping designers better understand how to optimise energy efficiency.

Generators can also examine the environmental impact of building materials by calculating the embodied energy and carbon print of a building and recommend alternative materials that offer better decarbonisation options such as improved durability, recyclability and biodegradability.

Monitoring the structural health of buildings

Buildings endure intense thermal and gravitational forces. AI tools can be used to both monitor and predict these forces identifying potential risks to buildings' physical structures, including signs that materials are underperforming – especially in commercial buildings that are older than 25 years.

Sensors attached to building façades can reveal the operational performance of a building, especially in regions where seismic forces are felt regularly, or locations where wind speed, caused by channelling (or funnelling), challenges safety measures. Increasingly, climate change-related extreme temperatures add a new dimension to consider.

Using data from these building sensors, AI systems can be trained to detect and predict structural damage, potentially extending the life of buildings and assets, and creating proprietary historical data sets that will help train future AI building systems.

AI for waste management in buildings

For many years, large municipalities (of more than a million inhabitants) have been investigating automated waste management. In that time, cities in Europe and North America have introduced pneumatic waste collection systems which transport waste through underground pipes from city centres to a central collection point. This system not only eliminates the need for waste collection by municipal vehicles, which clog traffic and produce greenhouse gas emissions, but also enables waste separation using AI image detection, which is faster and more efficient than manual separation.

Soon, all building owners in urban centres will be required to segregate their commercial waste into recyclables, landfill and composting. AI-powered sensors can monitor waste levels in real-time, allowing building managers to take efficient, informed decisions about when and how to dispose of waste. Data analytics from waste management systems can explain spikes in general waste output and identify longer-term patterns, both of which can be used to inform and adapt waste disposal procedures.

KEY TAKE-AWAYS

1. Digital twins are the latest AI-driven technology to test sustainable practices and provide a safe scenario planning 'environment' to test risks.

2. When building and remodelling workplaces, AI can be a powerful tool for informing sustainable building materials/assets selection, improving the accuracy of cost modelling and ensuring the efficacy of carbon reduction initiatives.

3. AI-enabled waste sensors are important and effective way for building owners to reduce waste-to-landfill from commercial buildings.

CHAPTER 3:

WORKPLACE EXPERIENCE

A commercial building has additional meaning beyond its apparent functional purpose; a prestigious building in an aspirational location can both engender a sense of pride among employees and elevate an organisation's brand. Alongside functional features, occupants' and users' emotional drivers must be considered in workplace design and experience.

The Covid-19 pandemic fundamentally altered society's view of the workplace and its impact on physical and mental health – this includes a heightened consciousness of how we interact with our colleagues and the built environment, a greater appreciation of 'healthy buildings' and even a general change in sentiment about using indoor spaces.

Leaders need to take this paradigm shift into account when considering how best to encourage a return to the workplace. Today, alongside being safe and secure, workspaces must welcome employees with enabled environments that allow seamless hybrid connection, ergonomic and collaborative spaces that shape organic cross pollination of ideas, and restaurants offering fresh, nutritional and sustainable food – workplaces that earn the commute.

Current challenges

According to Office for National Statistics (ONS) data from September 2022 to 2023, 44% of workers reported home or hybrid working, and 56% reported only travelling to work in the last seven days. A higher rate reported hybrid working, with 28% reporting hybrid working and 16% reporting working from home only. Among office workers, there is a clear 'us and them' situation developing, with some companies maintaining hybrid working levels while others are reducing them – in some instances, employers are monitoring office attendance, which has the potential to undermine employee engagement. Making workplaces that are attractive can help alleviate this tension, but new strategies must be deployed to achieve this.

Creating opportunities for employees to form relationships of support, cooperation, solidarity, and spirit of collective purpose heavily depends on how conducive the workplace is to do so. It is self-evident that the ergonomics of a professionally designed office space is generally superior to any home office: ensuring employees have the opportunity for human interaction and engagement within a physical workplace is essential for an organisation to build employee cohesion, and is a key step towards creating leadership and legacy.

Hybrid working can build social cohesion if done with specific purpose. For example, the need to allocate a day of the week to quietly work alone, think, read research materials, write up reports, and other forms of individualised work. However, employees also need a feeling of belonging, a team mentality, and bio-feedback between themselves and other people, which can only happen in the analogue world.

September 2022 to 2023

44%

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Working from home must be seen as a trade-off, not the norm. For hybrid working to be successful, employers need to understand why employees wish to work from home. Perhaps it is burn-out, or excessive long commuting, or having to tend to children – issues which might not necessarily present themselves in the workplace and could be resulting from individual lifestyle and/or societal changes. Understanding and addressing these issues is essential to enabling effective and accepted return-to-office strategies.

AI for space planning

Human creativity increases when we are exposed to other people's inspirational input. In innovation environments, inducing unexpected encounters is a well-established practice designed to increase the cross-pollination of ideas amongst colleagues. For example, at a global technology company based in Menlo Park, California, Pritzker Prize winner Frank Gehry introduced a one-mile-long open-plan office where meandering office desks, the absence of straight lines and furniture formations eased the casual encounters of employees of different departments – the interior design facilitated conversations and exchanges amongst people of different skills and backgrounds, igniting inspiration and curiosity.

Movement is a great indicator of the healthiness of a crowd and the safety levels of the people therein. A murmuration of starlings – which is both unpredictable and yet elegantly absent of crashes – can serve as a metaphor for how to enable colleagues to organically, yet safely, mix and mingle within the built environment. AI can be used to monitor workplace traffic flows (small groups and at scale); identifying patterns in people movement and helping workplace designers to learn about the usability and functionality of spaces, including if these are underutilised. Importantly, to be most effective and to avoid the feeling of 'Big Brother', it is essential that this type of people monitoring is fully transparent and done with the consent of employees.

AI for safer, more comfortable workplaces

Some AI vendors are offering camera monitoring systems that watch over personnel and alert when a person is experiencing trouble, for example, suffering a sudden stroke. Of course, due to privacy concerns, people monitoring can be controversial to deploy, and regulatory regimes, like European AI regulations (which prevent the excessive or unnecessary monitoring of individuals), must be considered. This type of monitoring is different to traffic and street cameras, which fall under a different jurisdiction as they are installed to monitor traffic and streets and treat humans as an indirect collective of 'humans in motion'.

Noise levels within the workplace can have a detrimental impact on some people's mental health and wellbeing. AI-driven, sensor-based solutions can help monitor high-decibel levels in public areas with noise spikes, such as cafeterias, entrance halls, and other spaces hard to sound-proof and with high volume of human traffic. The data can inform deployment of solutions like sound-proofed pods, small booths for taking telephone or video calls and other adjustments to reduce noise levels in public areas. These sound-limiting interventions are particularly relevant in workplaces, such as software development companies, where building users require quiet spaces for focused work and deep concentration.

Some organisations are considering the use of AI to gauge the mental health of an employee. For example, by monitoring an employee's voice to look for linguistic cues that indicate that they might be suffering increased stress levels; enabling employers to provide additional support.

Naturally, personal health is a sensitive issue and, as such, the use of individuals' health data in the workplace is a challenging and contentious issue. There is no doubt that the considered deployment of AI in this space could bring mutual benefit for employers and employees, but as a nascent technology, the ethical debates on its application are ongoing and remain unresolved.

AI for food management

Introducing AI in professional kitchens is not about bringing in cooking robots that will supplant chefs and their kitchen brigades – it is about optimising processes by streamlining operations and reducing costs. A well-managed kitchen is interdependent on what happens inside and outside of it: cooking with fluidity and precision is as important as tapping into reliable produce suppliers that will deliver daily (where sustainability policies allow), because food is best when it goes from farm to dish, rather than from farm to shelf to dish.

Professional produce suppliers have become incredibly sophisticated where it comes to ripeness while on transport – something that supermarkets demand of farmers as produce goes straight from van to supermarket shelf. In a professional kitchen, a perfectly ripe tomato is one that arrives ready to be cooked and served on the day. As the ripening of a tomato - as well as many other fruit and vegetables - is mathematically predictable (standard-sized tomatoes can take between 20 to 30 days from blossom set to reach full size–commonly called "mature green" and be picked when they start colouring towards their varietal palette of pinks, reds, purples, or dark greens. Room temperature will then bring them to their full ripeness if kept between 20 to 25 degree-Celsius), AI can be deployed to precisely manage the variables and intricacies of their complex

supply chain. And, since AI learns to function within a rules-based system and can teach itself to continuously optimise supply and demand flows, it can help integrate inventory and purchasing systems, including bespoke back-office kitchen systems.

Cooking is a creative process that requires tremendous organisational skills and abilities. For example, beyond simply reading and executing recipes, chefs must be able to multi-task and use their ingenuity to run sustainable kitchens that guarantee reduced food waste. Again, AI can help by reworking recipes and coming up with creative suggestions by simply rotating and combining available seasonal produce and ingredients; enabling cost-efficient purchasing. It can also accurately design recipes that are tailor-made for diabetics, account for intolerances or other dietary requirements, and created in accordance with food safety and industry standards. AI in food management can be particularly powerful in large commercial kitchens, where scale, volume and complexity are greater.

In terms of sustainable food management, AI can consider many variables that indicate diners' future eating behaviours and, as such, be used to actively manage food supply and demand. For example, it can handle substantial variable data streams like the weather, which has a direct correlation on consumers' buying behaviours – in Germany, as temperatures reach specific levels, people crave fresh watermelon. Additionally, in good weather, employees abandon staff restaurants in favour of eating al fresco on the lawn of a nearby green. Some of this behaviour is already well known in the food and kitchen trade, however, behavioural AI has an ability to reveal 'unknown unknowns'; that is, hidden untapped insight that deepens our understanding of the way that people make decisions; enabling sustainable food management.

Finally, AI can now deliver personalised experiences for diners – including a frictionless buying experience – enabling both improved food choices for customers and a reduction in food waste.

KEY TAKE-AWAYS

1. A workplace is an invaluable space for human interaction – when deploying AI, companies should invest in initiatives that foster social cohesion, increase people's creativity and support their wellbeing.

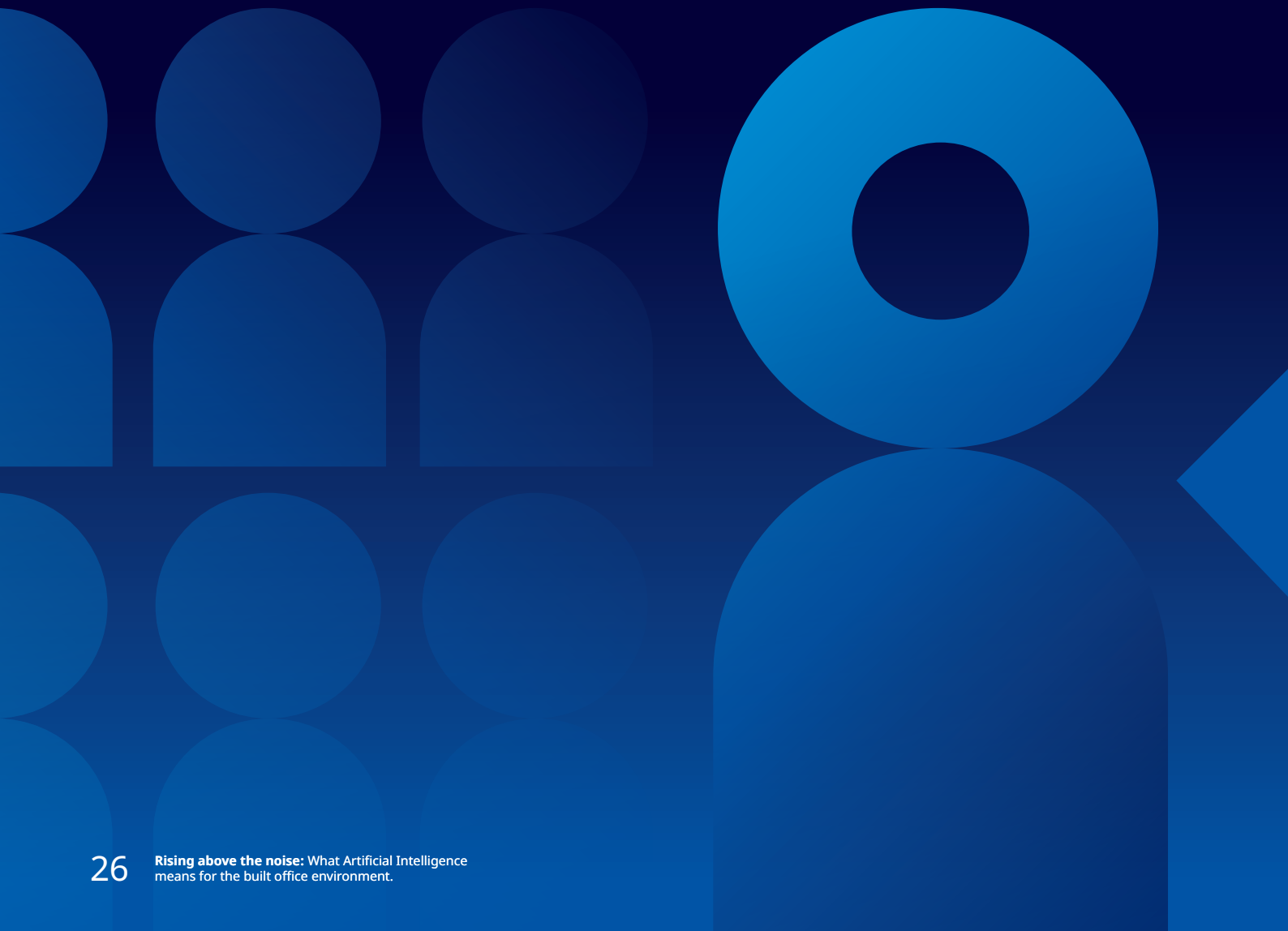
2. Workplace designers can use AI to monitor traffic flows and people movement patterns to design spaces that encourage cross-pollination of ideas and collaboration.

3. AI can identify patterns and correlations that help food teams design menus that maintain the difficult balance between efficiency, sustainability and waste reduction, and the nutritional needs and aspirations of diners.

CHAPTER 4:

TALENT ATTRACTION AND RETENTION

Attracting and retaining the most valuable and promising human capital is key to an organisation's long-term success. Whether it's 'turnaround CEOs' rescuing companies on the brink of demise, or star employees driving innovative and creative approaches that deliver competitive advantage – 'People make or break businesses' is a concept that repeats itself across history.



However, in a digital world filled with online 'professional' profiles, where applicants can respond directly to job advertisements, and in an era when social media can be used to scrutinise and critique potential employers, candidate selection presents an evolving and dynamic challenge for People & Culture functions.

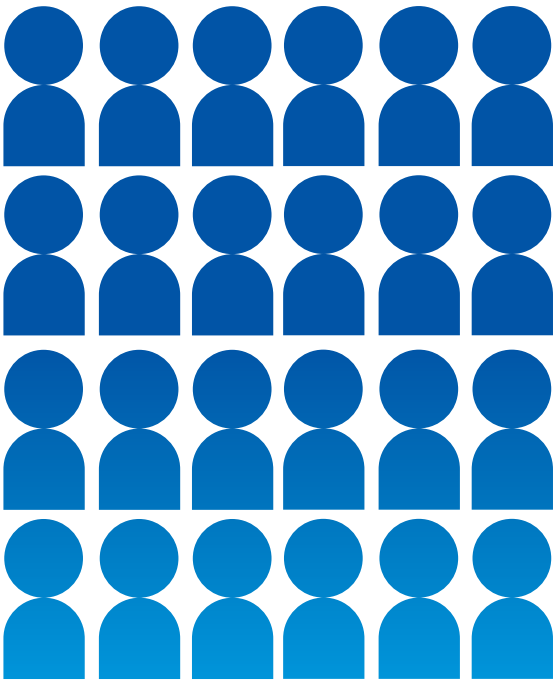
Although AI has been used as a tool to review and select CVs and job applications for the last ten years, it still underperforms when fighting bias and discrimination. Automated AI sourcing shows bias when searching terms, headers, job titles and university degrees, and making assumptions as to how candidates should be evaluated. Applicant tracking software (ATS) systems are still poorly trained, resulting in algorithms that discriminate against talent from minority populations in favour of those from racial, economic, and/or religious majorities.

AI for candidate sourcing

Manually selecting and screening talent at scale is a cumbersome process. AI can help People & Culture functions in this process. However, it has limitations: it uses parameters like job titles, skills, keywords and location to find the best matches for open positions, but the best candidates do not necessarily use the same taxonomies for titles and jobs. The limitations become particularly pronounced when searching for candidates across countries where educational qualifications, ranking systems and job titles differ across sector and industry.

Also, the unique value that individual candidates may bring to a team and organisation is not purely objective or precisely quantifiable. For example, a female industrial engineer will bring added value to a male-dominated department, and a student who has gained knowledge and experience via non-academic routes may bring different perspectives and different appreciation of value. Further, academic prowess alone has never been the bellwether of success, especially in entrepreneurial environments – educational skills and teamwork protocols (derived from sports training, as many excellent business leaders with previous sports or military careers denote), add incredibly powerful dimensions to appreciating the value of a future candidate for executive leadership programmes within an organisation.

Whether AI can find a place within this subjective context is as yet unproven – however, what we do know is that a smart organisation should use both AI-driven candidate selection tools coupled with analogue protocols at both CV review and interview stages in order to appreciate the nuances of each individual applying for a job. After all, what the new generation of candidates seeks the most is to be appreciated via a kaleidoscopic approach.



AI for employee retention

AI can predict employee desertion, tiredness, lack of passion, disinterest, disengagement and apathy. However, the ability of an AI system to interpret this behavioural data is only as good as the tactics deployed to gather it. Anthropologists and behavioural psychologists are required to train behavioural AI systems, including labelling of collected data. In addition, they must assert contexts and decision-making on the behaviour recorded. For example, some employees may arrive much earlier than everyone else and depart in the same fashion because they have trains to catch, so commuting patterns are an easy behaviour to assess. However, engaging in projects, volunteering in activities, eating at one's desk or in the cafeteria can denote isolation, pressure or a lack of social skills, and these are behaviours that require further data sets to accurately interpret.

Recently, the growing custom of 'quiet quitting' from a job has become a challenge for many companies. Of course, what makes one generation remain at a job is very different to what makes another consider staying – for instance, a parent may stay in a disliked job because of their family's financial obligations, whereas a recent graduate may feel forced to stay in order to pay back student loans. An AI system can study the tipping point for both employees to determine which of the two might quit first. It can also be trained to determine which incentives may be more attractive to each generation, for example, salary increases, paid holiday entitlements or even reduction of weekly hours or work shifts.

Some companies are going beyond these quantifiable incentives and have begun to train AIs with abstract value systems, such as deferring promotions in favour of more flexible hours, or using company hours to work on personal projects – something that Google pioneered, which yielded genius employee-developed products like Gmail and Google News.

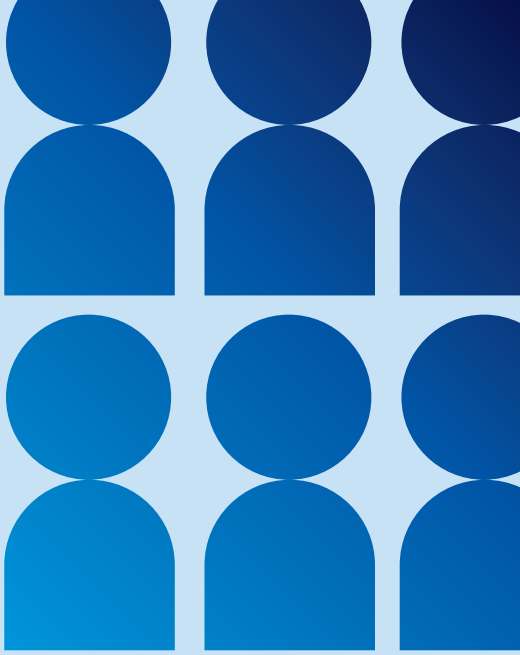
Further, AI recommender systems can help re-engage employees. Most employees declare not being aware of an organisation's perks because of a lack of information, however, filtering algorithms – similar to those Amazon uses to make product recommendations ("Customers also bought…") – can be used to ensure that employees are well acquainted with relevant development opportunities, employee discounts and other available rewards, designed to drive employee engagement. One of AI's superpowers is the ability to suggest something at the correct time and at the most opportune moment, and People & Culture functions should consider this powerful targeting capability when building digital engagement programmes.

AI for tacit knowledge transfer

'Tacit' knowledge comprises the knowledge, skills, and abilities that someone gains through experience, and is often difficult to express in words or otherwise communicate. It is impossible to train a machine to learn tacit knowledge because it is the opposite of formalised, codified or 'explicit' knowledge, which can be stored, listed or broken down into steps.

Because it cannot be verbalised, it is very hard to transfer to another individual. It cannot be taught or described in a manual, and is incredibly difficult for companies to leverage once a senior and/or skilled employee departs. It is the knowledge of people like artisans, writers, risk analysts, sales executives, car mechanics, chefs, carers, teachers, taxi drivers, shepherds, etc. – it is a neotenic knowledge and only humans can acquire it.

A clear instruction manual can help most people figure out how to build a flat-pack table. However, a person who has built lots of flat-pack furniture knows all too well that many instruction manuals lack a specific step, or omit something incredibly subtle that only the tacit knowledge of having built self-assembly products over many years can provide. This is a simple example of how humans can solve problems in ways that AI cannot. That said, AI can be deployed advantageously in a training context, for example, by pairing individuals to help maximise skills training



effectiveness, or assisting people in acquiring and testing new skills (for example, a foreign language). Ultimately, however, AI can neither acquire nor impart tacit knowledge.

Enabling people to realise their potential, find their purpose, be confident in their skills and feel supported by their organisation are the fundamental goals of employee engagement. Deploying talent and attraction frameworks – in which AI is the tool but humans are the driving creative force – is the key to igniting in employees the fire to apply themselves with authentic passion. It is an ambitious endeavour and, perhaps, the zenith of what might be achieved in human-machine collaboration.

KEY TAKE-AWAYS

1. Human bias is already embedded in companies' hiring practices. AI must not be an additional layer of partiality and discrimination – it must be designed and deployed to fight and eradicate this human flaw.

2. As AI is adopted, organisations must continue to foster environments and establish practices that enable and encourage tacit knowledge transfer.

3. Hire the best, mentor the promising, protect the vulnerable, and provide a voice to those who feel unheard; these are fundamental, human centric values that should guide adoption of AI.

CHAPTER 5:

INFORMATION SECURITY

Organisations' information security encompasses many tiered dimensions that have traditionally included physical, digital, financial, and the safety of the workforce. In the next five years, security will expand to areas such as ensuring the health of employees, creating a culture of security awareness (especially in the cyber context), and the governance of data & intellectual property in the hybrid environment.

Current challenges

Information security in the 2020s is decentralised – it is no longer based on the 'moat around the castle' paradigm that built firewalls around server architectures, or on building access via company-issued entry badges. Today, cybersecurity experts point to the unwitting behaviour of individuals as the most prevalent cause of security breaches. For example:

- Phishing attacks via email
- Ransomware attacks – encrypting a victim's data until a ransom is paid
- Unauthorised data breaches
- Malware infections
- Insider threats due to malicious intent or human negligence

Whilst less in number, attacks initiated and executed from outside of an organisation, still present a serious threat:

- Denial of service (DoS) or distributed denial of service (DDoS); targeting network infrastructure to make it inaccessible
- Credential stuffing; attackers purchase lists of emails and passwords on the dark web and use them to gain unauthorised access to systems
- Man-in-the-Middle (MitM) attacks; attackers intercept communications
- Social engineering; victims are manipulated into revealing confidential information – a typical occurrence in retail banking
- Zero-Day exploits; attackers take advantage of software vulnerabilities before vendors can fix them with a new software release

As the business digital landscape continually expands, and with it, new cybersecurity vulnerabilities, attackers will adapt their tactics to exploit this. Indeed, alongside increased security benefits for organisations, AI will also enable attackers to mount new and more nuanced cyberattacks. To help combat existing and new threats, alongside the adoption of new technologies like AI, timely and agile employee education/awareness must remain a key priority/strategy for organisations.

For some time, office buildings' security systems have ensured the safety of occupants, protected properties, equipment and inventory, and prevented unauthorised access. Today, new systems are encompassing a range of technologies and measures that leverage emerging technologies like AI; biometric scanners for access, motion and thermal capture sensors for intrusion detection and computer vision surveillance (detecting humans, animals and vehicles, as well as fire and water hazards and/or explosives). As such, a key priority for governments around the world is the development of legal frameworks that govern the ethical deployment of AI-enabled digital and physical security.

Guaranteeing identity safety

Identity data is likely to become one of the most regulated fields of AI policy. So, whether it is physical or digital security, as organisations adopt AI-driven solutions, new and evolving legislation must be considered. This includes the need to rethink of how employers create and manage the identity data held in employee profiles.

Biometric data is increasingly being used to provide physical and digital access. For example, ePassport gates use facial recognition software to verify a traveller's identity by scanning their face and matching it with the data stored on the biometric chip in their passport. However, as this data-matching is performed with two-dimensional data (e.g., passport photos), in most cases, a border control officer still has to make the ultimate decision. In addition, it is deployed for facial recognition on mobile devices that use 3D depth sensing and 'liveness detection', like on Apple's Face ID. As it cannot be fooled by a static image or video of the user's face, this system is generally more accurate and secure than simple 2D image-based systems.

Biometric data sources are also being combined to improve security. For example, voice recognition is increasingly used for multi-modal integration – where voice can be used in combination with other factors, like facial recognition or fingerprints, to create multi-factor authentication.

That said, biometrics still have limitations when it comes to identity verification, and, as such, employee education/awareness (about PINs, passwords and general cybercrime) should remain the first step in improving identity security. Further, it is important to recognise that biometric recognition can be prone to bias, possibly leading to higher error rates for certain demographic groups, which raises concerns about fairness and potential discrimination – this is a key concern for regulators considering the use of AI in biometric security.

Human motion surveillance and digital tracking

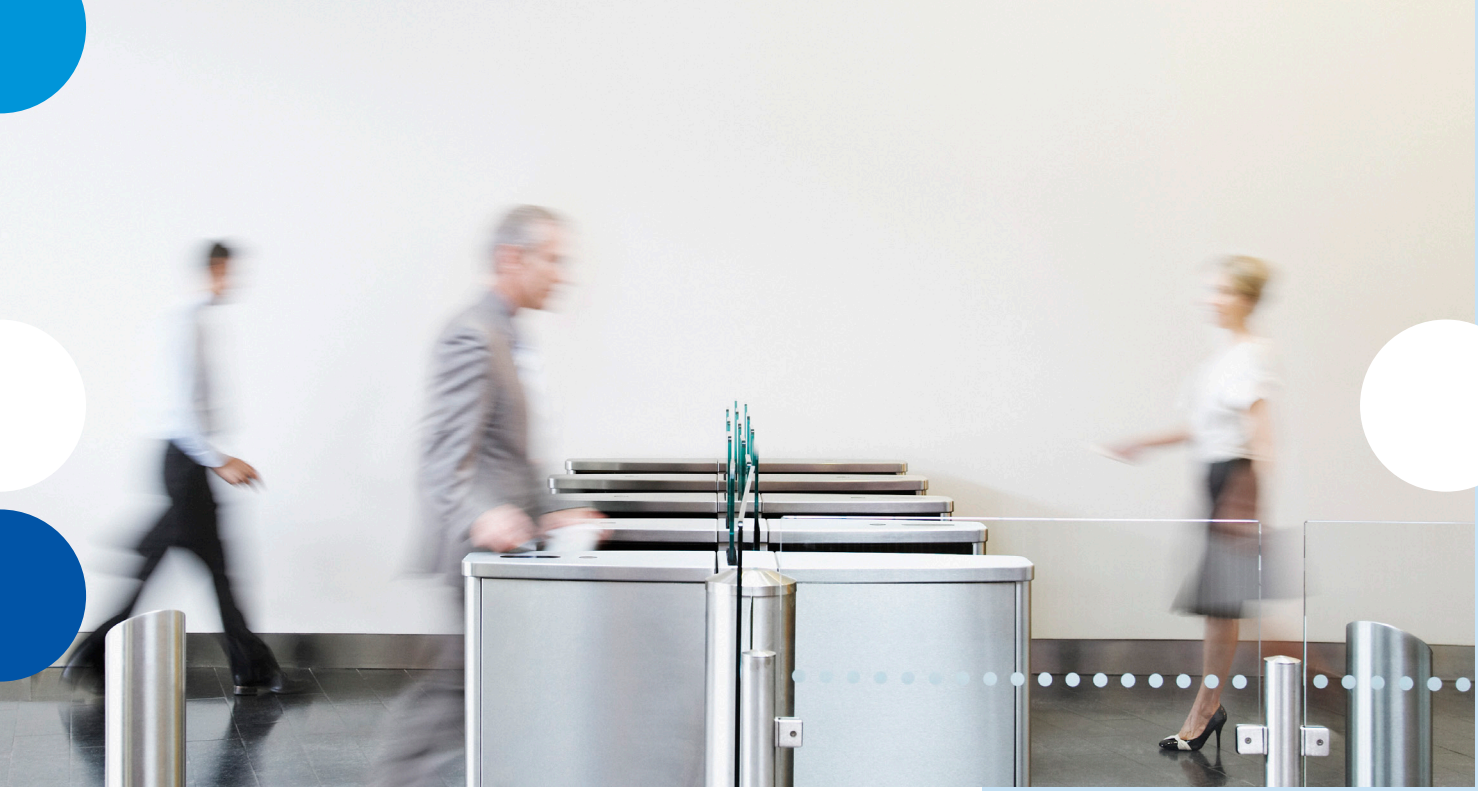
Increasingly, effective and secure building management requires knowledge of where building users are and how they use workspaces. In addition, understanding and guiding employees' digital behaviours is essential to maintaining robust cybersecurity systems and compliance regimes.

To enable this, AI-created algorithmic models are being used in both human motion surveillance systems, which record the location of people within buildings, and digital tracking systems, which record the breadcrumbs that users leave within digital systems (for example, log-in behaviour, servers accessed and files downloaded/printed). It should be noted that these powerful monitoring systems raise ethical and privacy concerns that need to be carefully considered.

While it is not unlawful to monitor and analyse movement of people using human motion surveillance, careful consideration must be given to the purpose and intended use of the captured data. At times, this may not be straightforward; for example, a surveillance camera in an employee restaurant could be used to recommend available seating and ease customer traffic flow. Equally, the data from the same surveillance camera could be used retrospectively to investigate the cause of a fire. In advance of use, scenario planning should be used to anticipate and agree the purpose and use of human motion surveillance. In a scenario that was not anticipated, when it comes to deciding on whether the data can be used for this new use, an additional assessment as to whether it is lawful must be undertaken.

In relation to employee behaviour, compared to AI-enabled human motion surveillance, AI-enabled digital tracking provides even greater visibility. This is because digital assets (like laptops, mobile phones, etc.) are proprietary to an employer and provided to employees for work use (in many instances, exclusively work use), and therefore an employees' individual use of this equipment, including their compliance with security processes and systems access history, is recorded. As such, the ethical and regulatory implications of its use need to be considered.

In addition, society previously deemed an individual's social media activity to be a personal matter. Today, an employee expressing a socially unacceptable opinion (e.g., through hate speech) on their own social media can damage their employer's brand – in particularly grievous instances, legislators are beginning to consider this a potential breach of contract. As such,



employees use of social media is another area where digital tracking is also being deployed by some organisations to protect their brands. Again, the ethical and regulatory implications of its use need to be considered.

Although AI-enabled human motion surveillance and digital tracking are extremely powerful tools, it should be acknowledged that, if not properly managed and analysed, data collected through these means can perpetuate damaging bias and discrimination. Balancing the benefits of these technologies with ethical considerations and privacy protection requires transparent policies, strong data security measures, and adherence to relevant laws and regulations.

KEY TAKE-AWAYS

1 AI can play a central role in providing both physical and digital security, alongside an enabling role in maintaining healthy, safe environments that foster inclusivity, equity and wellbeing amongst employees and visitors.

2 The digital landscape is always changing and AI will enable attackers to mount new and more nuanced cyberattacks – alongside adoption of new technologies like AI, timely and agile employee education/ awareness must remain a key priority/strategy for organisations.

3 Regulating the ethical use of AI in security is an evolving area and key priority for governments worldwide – interpretation and application is not always straightforward and organisations should take a proactive approach to managing this complex challenge.

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RISING ABOVE THE NOISE

In describing and forecasting practical AI solutions for the built environment, this white paper, authored by Inma Martinez on behalf of ISS, has sought to "cut through the noise" around AI, much of which was prompted by the mainstream release of Generative Pre-trained Transformers (GPTs).

GPTs are being used for many applications, ranging from code-writing, co-pilot risk analysis in asset management and verifying regulatory infringements in financial transactions, to summarising longform written content. For example, a verbatim summary of this whitepaper, as generated using a GPT platform. →

As we stand on the brink of a transformational era in the built office environment, it is clear that Artificial Intelligence (AI) is not just a tool for innovation, but a catalyst for a more sustainable, efficient, and human-centric future. The insights from the various chapters of this white paper underscore AI's potential in redefining energy management, building sustainability, workplace experience, talent attraction and retention, and information security.

As we embrace AI-driven solutions, from microgrids for smarter energy use to AI-enabled waste sensors for efficient waste management, we are not just optimising our resources but also paving the way for a more sustainable and responsible approach to business operations. In enhancing workplace experiences, AI stands as a guardian of creativity and well-being, fostering environments that encourage collaboration and innovation. In talent management, AI emerges as a tool for equity, removing biases and creating inclusive workplaces. And in the realm of information security, AI proves to be a vigilant protector, ensuring safety and integrity in an increasingly digital world.

This journey with AI is about harmonising the technological environment with the human, ensuring that as we advance technologically, we also progress in creating workplaces that are not only smart and efficient but also nurturing and inclusive. The future beckons with promises of an AI-integrated work environment where technology and humanity coalesce to create spaces that are not just about work but about people thriving and businesses flourishing. As we venture into this new era, let us harness AI not as an end, but as a means to enhance our greatest asset – our people and the environments they thrive in.*

www.risingabovethenoise.ai

*produced using a GPT platform

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