FIRST Q EXPERT PERSPECTIVES

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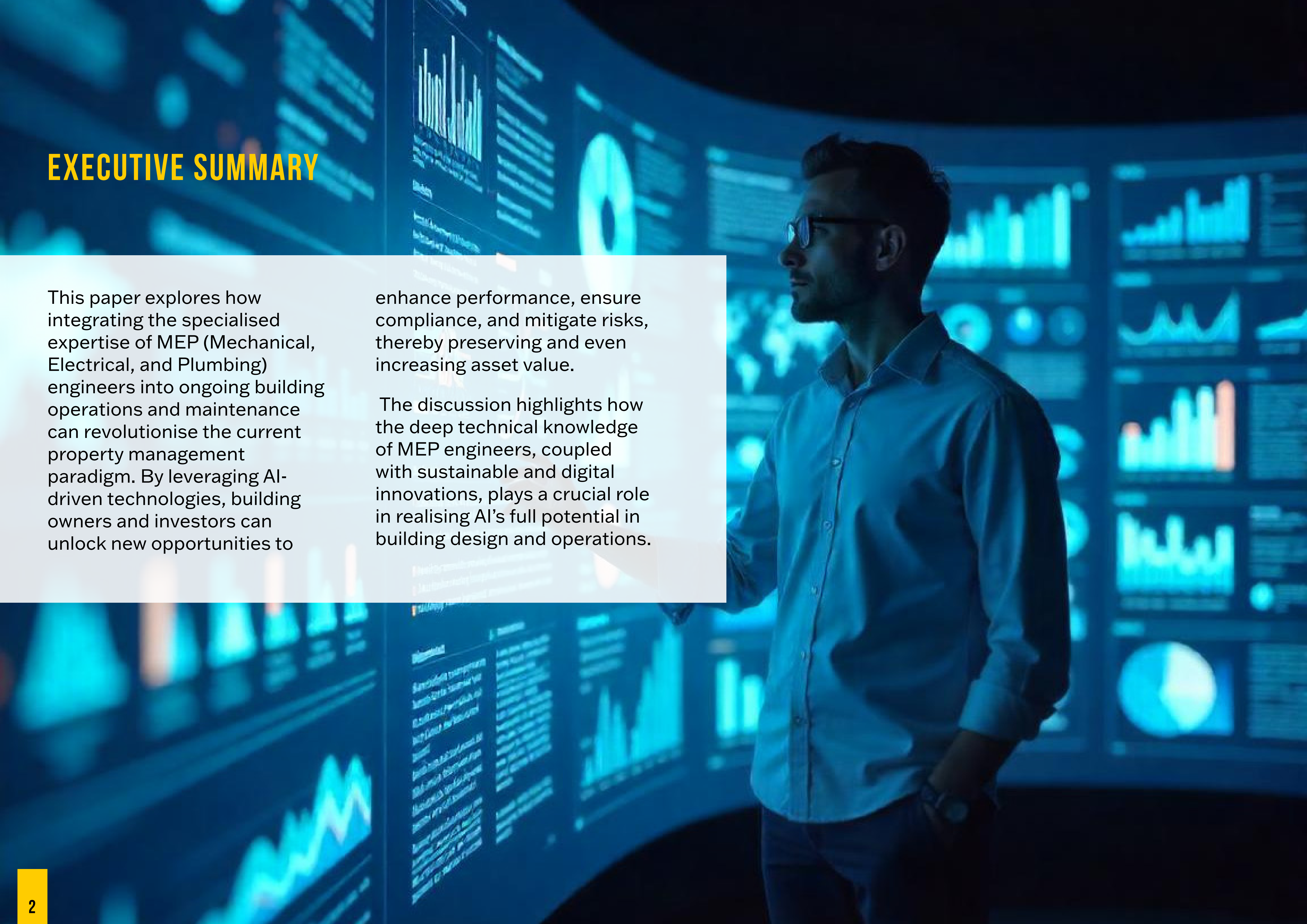
UNLOCKING AI'S POTENTIAL IN BUILDING DESIGN AND OPERATIONS:
THE VITAL ROLE OF MEP ENGINEERING IN REAL ESTATE

ZWP Ingenieur-AG
a member of the FIRST Q network

FIRST Q NETWORK

SMART BUILDINGS ENGINEERED



EXECUTIVE SUMMARY

This paper explores how integrating the specialised expertise of MEP (Mechanical, Electrical, and Plumbing) engineers into ongoing building operations and maintenance can revolutionise the current property management paradigm. By leveraging AI-driven technologies, building owners and investors can unlock new opportunities to enhance performance, ensure compliance, and mitigate risks, thereby preserving and even increasing asset value.

The discussion highlights how the deep technical knowledge of MEP engineers, coupled with sustainable and digital innovations, plays a crucial role in realising AI's full potential in building design and operations.

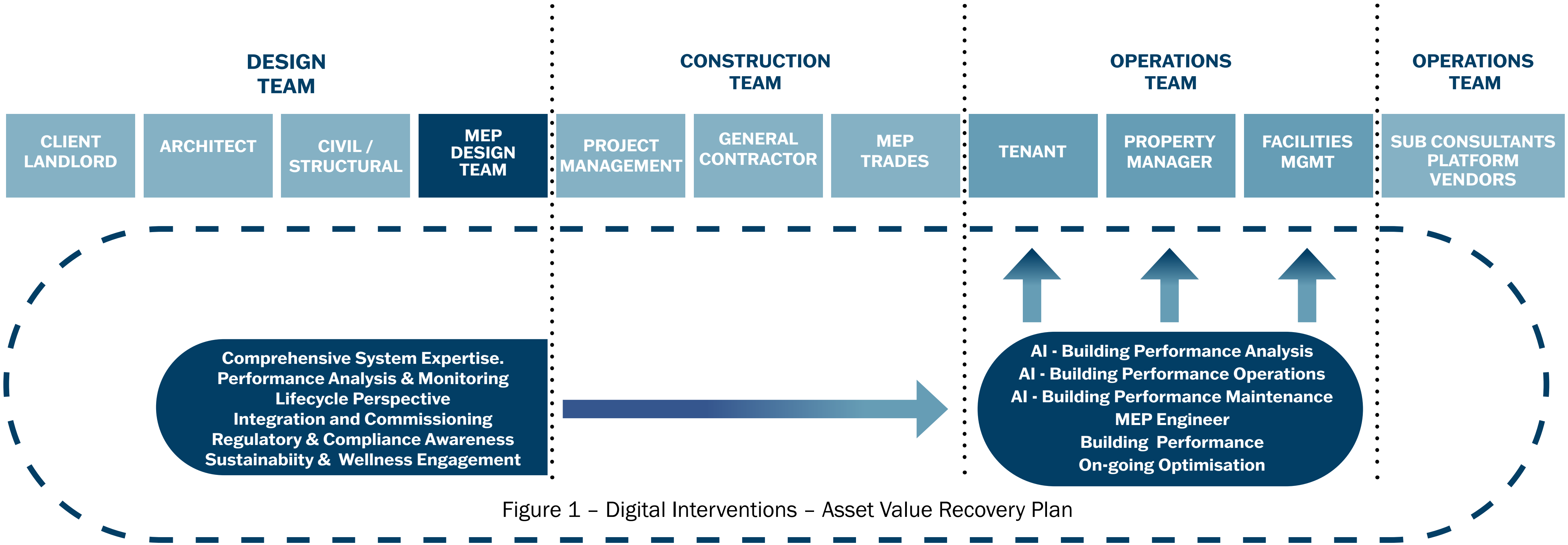


Figure 1 – Digital Interventions – Asset Value Recovery Plan

INTRODUCTION AND CONTEXT

Artificial Intelligence (AI) is rapidly gaining prominence (McKinsey & Company, 2024) and finding diverse applications within the building services sector (Memoori, 2024). A forward-looking vision sees AI becoming an integral part of every aspect of a building's lifecycle, from design and construction to operational management. Despite its promise, the adoption of AI also presents significant data challenges, that must be addressed in every stage of the project (RIBA, 2024), ensuring data security, achieving seamless system data integration, maintaining regulatory data compliance, and enhancing data accuracy. To address these concerns, regulatory measures like the EU Artificial Intelligence Act (European Commission, 2023), aim to establish safeguards that ensure ethical and secure AI implementation.

Modern buildings are becoming increasingly complex, integrating data analytics, advanced building systems, and emerging AI tools. To effectively manage and leverage these capabilities, the domain knowledge of Mechanical, Electrical, and Plumbing (MEP) engineering teams becomes indispensable. AI's strength lies in pattern recognition and automation, but it cannot replace the creativity, conceptual understanding, and nuanced expertise of human engineers (CIBSE Journal, 2024). Instead, AI should serve as a facilitator, enhancing the strategic and creative roles of MEP engineers.

At the same time, the industry faces a growing lack of technical staff and expertise to design and operate increasingly sophisticated buildings. In this context, AI will play a critical role in bridging the gap by supporting and optimizing building operations. This shift will enable smarter, more resilient infrastructure while allowing engineers to focus on higher-level strategy and innovation. Reflecting on insights from our previous paper, A Digital Driven Approach is the Fastest Pathway to Achieving Net Zero Buildings (First Q Network, 2024), the imperative for digital transformation in the built environment is clear. This foundational work underscored how digitalisation supports EU decarbonization and energy transition requirements, helping to avoid stranded assets. As can be seen in Figure 2, the next step in this journey is unlocking the full potential of AI to drive efficiency, sustainability, and value across the building lifecycle.

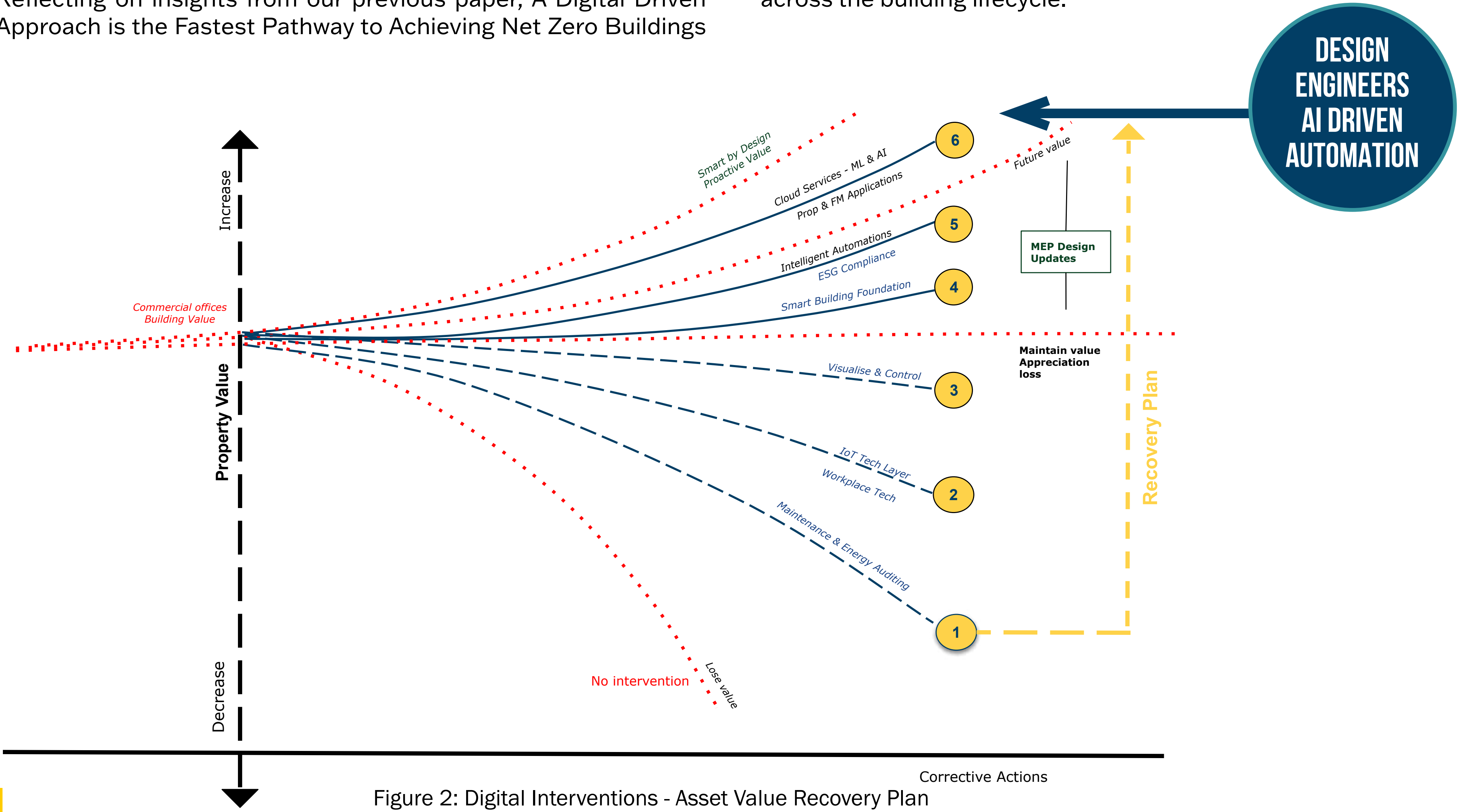


Figure 2: Digital Interventions - Asset Value Recovery Plan

THE STRATEGY TO UNLOCK AI POTENTIAL

To fully unlock AI's potential in the building lifecycle—spanning design, construction, and operation—a comprehensive strategy is essential.

1

BRIDGE KNOWLEDGE GAP

AI developers often lack understanding of building operations, while facilities managers may not have the MEP expertise to align operations with design intent. Upskilling and **collaboration between AI developers and MEP engineers** can address this gap. For example, creating shared training programs and collaborative AI workshops can ensure both groups understand the operational nuances and technical requirements of building systems.

2

FOCUS ON DESIGN-OPERATIONAL ALIGNMENT

MEP engineers must be **integral** in defining both the physical and digital frameworks of buildings, ensuring AI solutions align with the original design intent. **Early integration of MEP insights** during AI development ensures a seamless transitiontween design and operation phases, reducing inefficiencies caused by misaligned objectives.

3

ADOPT AI INCREMENTALLY: IMPLEMENT AI TOOLS STEP-BY-STEP, STARTING WITH "QUICK WINS"

In areas like energy optimisation and predictive maintenance. For instance, an incremental rollout could begin with automated energy audits before advancing to comprehensive building automation systems. This phased approach minimises risk and **builds trust in the technology**, allowing stakeholders to see immediate benefits.

4

ENSURE REGULATORY COMPLIANCE

Leverage the expertise of MEP engineers to ensure AI systems comply with general regulations, such as the EU AI Act—addressing safety, transparency, and data protection—as well as specific global and local building regulations, including technical and performance requirements. **MEP engineers serve as intermediaries**, translating complex regulatory frameworks into actionable design and operational guidelines for AI developers.

5

EMPOWER ENGINEERS WITH AI TOOLS

Equip MEP engineers with AI collaboration tools, enabling them to **monitor, refine, and adapt** building systems throughout the lifecycle. Tools like digital twins, augmented reality platforms, and machine learning algorithms can significantly enhance their ability to oversee complex systems and large portfolios and predict performance outcomes.

THE ROLE AND SKILLS OF MEP ENGINEERS

MEP engineers are uniquely positioned to enhance the implementation of AI tools in the building sector by leveraging their expertise in:

SYSTEMS INTEGRATION

Ensuring seamless interoperability between AI-driven tools and existing building systems. For example, integrating AI-powered HVAC systems with building management software to enable holistic energy optimisation

DATA ANALYTICS

Identifying relevant data points for AI training and aligning analytics with operational goals. Engineers can guide AI developers in selecting meaningful metrics, such as occupancy trends, energy peaks, or equipment degradation rates.

SUSTAINABILITY INSIGHTS

Embedding AI systems within sustainable design principles, reducing carbon footprints and resource consumption. AI tools informed by MEP expertise can prioritise energy sources activation and optimise resource allocation.

REGULATORY OVERSIGHT

Guiding AI systems to meet safety and compliance standards, especially for critical infrastructure. This includes evaluating AI algorithms to ensure they do not compromise building safety, machine degradation or violate operational codes.

STRATEGIC CREATIVITY

Leveraging AI as a tool to innovate in design and operations while preserving the human element. Engineers can use generative design platforms to explore new architectural concepts that align with both technical and aesthetic goals.

Combining AI and digital technologies with MEP engineers' expertise empowers the building industry to bridge the gap between design and operational performance. This synergy aligns with the 3Ps Framework for a successful data and AI strategy (Databricks, 2023): Process, People, and Platform. Digital transformation strategies, as AI implementation, are driven by people who implement successful projects to optimise and streamline processes. At the core of any digital transformation strategy lies the platform, which must seamlessly integrate with existing IT infrastructure or connect to the broader IT ecosystem, as can be seen in Figure 5.

A successful AI implementation strategy aimed at delivering high-performing buildings must directly influence the 3Ps

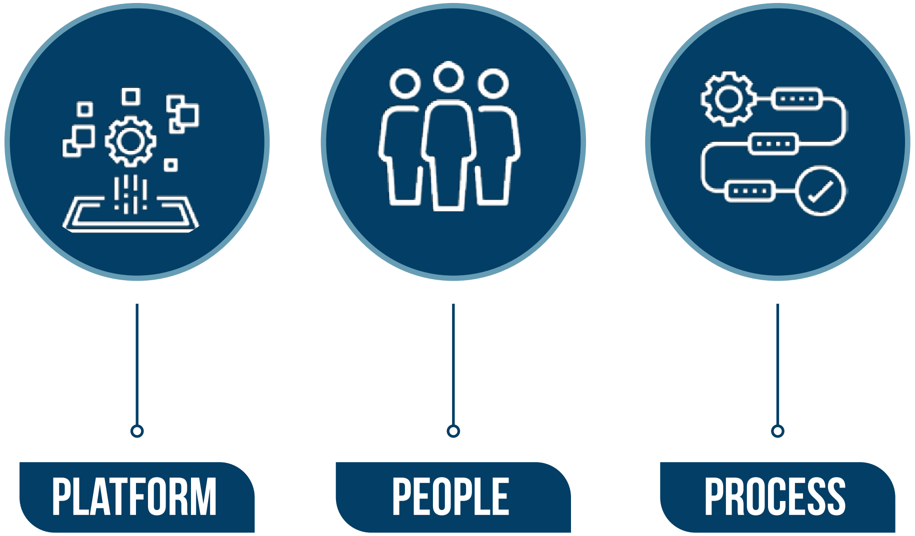


Figure 3 - AI Implementation

Together, the elements of the AI strategy unlock value for stakeholders and empower engineers to address the evolving challenges in the built environment proactively.

VALUE OF AI TO STAKEHOLDERS

Developers and Owners

Improved Project Efficiency
MEP-driven AI reduces delays, enabling faster project delivery and smoother transitions to operations. For instance, AI-enabled project management tools streamline scheduling and resource allocation, reducing bottlenecks during construction.

Enhanced Asset Value
AI-optimised buildings command higher market value due to increased operational efficiency and adaptability. By incorporating cutting-edge technology, developers attract investors and tenants looking for intelligent, future-ready spaces.

Reduced Lifecycle Costs
Sustainable AI integration minimises retrofitting and operational inefficiencies. Early integration of AI in design ensures long-term cost savings by optimising resource use and reducing maintenance needs.

VALUE OF AI TO STAKEHOLDERS

Operators

Optimised Performance:
Predictive maintenance and adaptive controls significantly enhance energy efficiency and system reliability, leading to substantial operational cost savings. By analysing equipment behavior patterns, AI can proactively identify potential failures, allowing for preventive measures that ensure consistent performance and reduce unplanned downtime.

Enhanced Decision-Making
Data-driven insights align resources with operational needs, reducing downtime and waste. Operators can use AI-powered dashboards to visualize performance metrics and implement informed adjustments in real time.

Adaptability
AI-designed modular systems allow for scalable upgrades and integrations. For example, operators can integrate emerging technologies like IoT-enabled sensors or machine learning algorithms without disrupting existing infrastructure.

VALUE OF AI TO STAKEHOLDERS

End-Users

Personalised Comfort

AI dynamically adjusts temperature, lighting, and ventilation, enhancing occupant satisfaction. For instance, AI systems can learn individual preferences over time, tailoring environmental settings for maximum comfort.

Health and Well-Being

Improved air quality and environmental monitoring directly benefit occupants. AI systems can detect and mitigate indoor pollutants, allergens, or CO_2 levels, creating healthier living and working environments.

Transparency and Engagement

AI dashboards provide users with actionable insights into resource consumption and comfort levels. Through real-time feedback, occupants are empowered to make informed decisions that reduce their environmental impact while enhancing overall satisfaction and well-being.

SUMMARY OF POTENTIAL AI APPLICATIONS

As AI continues to proliferate, its underlying technology and value-creation mechanisms evolve from basic to advanced and generative capabilities, enabling more complex, integrated, and automated applications. AI can be applied to numerous intelligent building systems, with its value potential increasing as AI improves and autonomously optimises more integrated building systems (ASHB, 2024). Figure 4 illustrates the Intelligent Building AI Use Case Map, highlighting the building applications where AI adoption is expected to occur most rapidly.

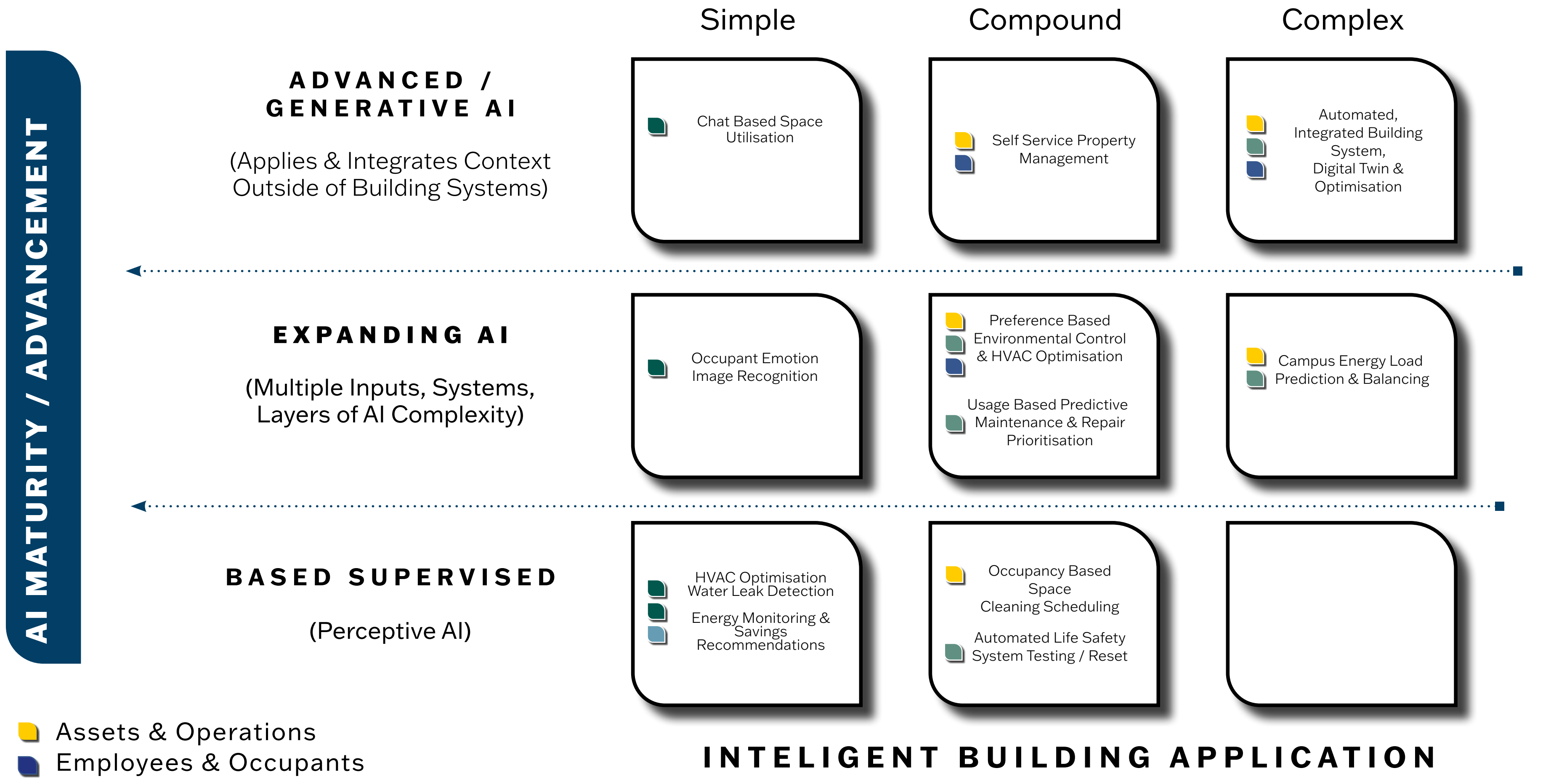


Figure 4 - Inteligent Building AI Use Case Map (ASHB, 2004)

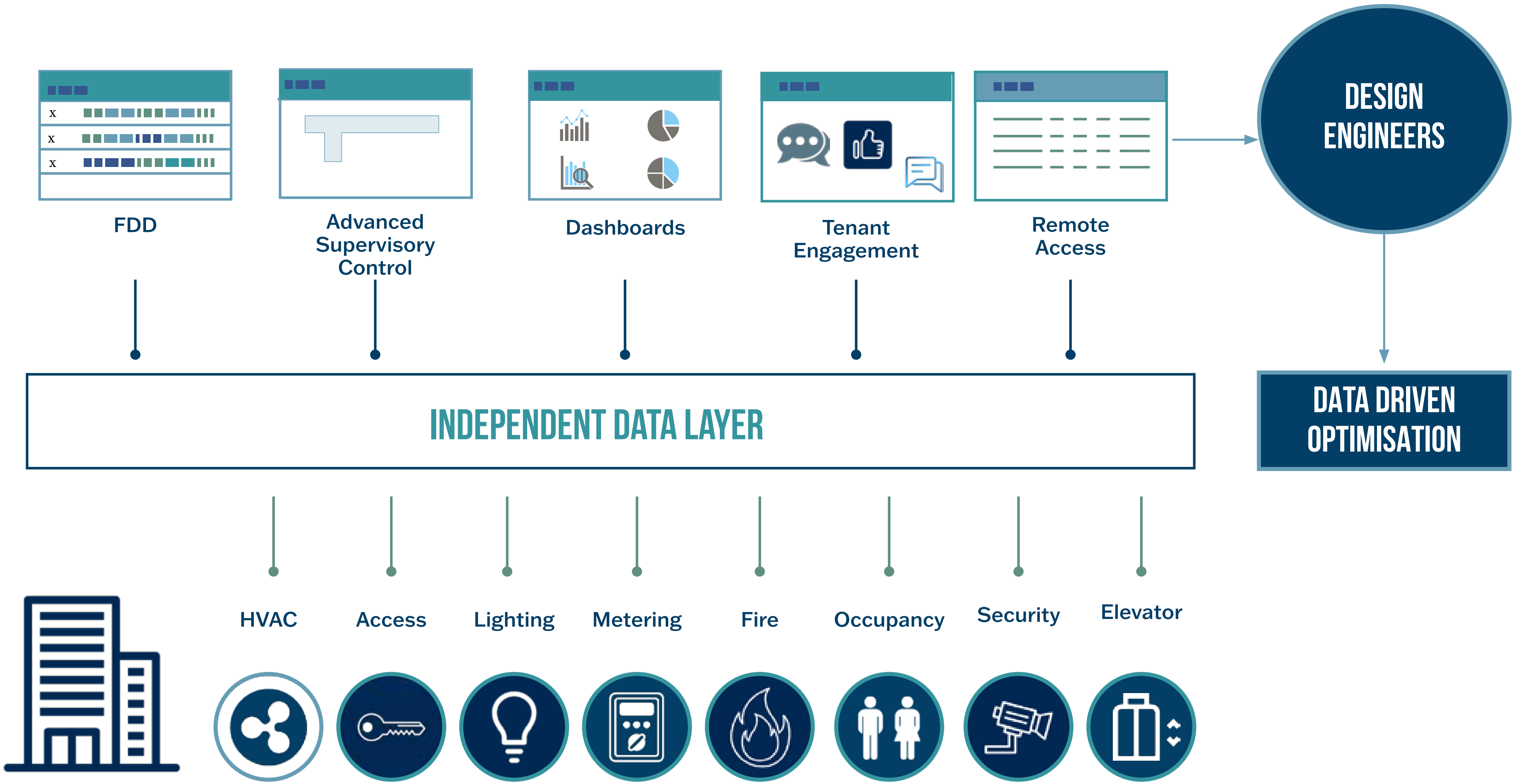


Figure 5 – Independent Data Layer as core of any digital transformation

DESIGN

Additionally, some potential AI applications discussed in CIBSE (2024) and Memoori (2024) have been analysed by the First Q Smart Building Working Group and are included in the following table as a comprehensive summary of the preceding sections.

Action	Description	Outcome	Benefit	Impact
Generative Design	AI-driven algorithms generate optimised design solutions based on constraints and goals.	Optimised design iterations aligned with goals.	30% reduction in design time. Cost savings by reducing manual iterations.	High
Parametric Modeling	AI integrates with parametric tools to create adaptive designs.	Efficient, aesthetically coherent designs.	20% reduction in rework costs. Cost savings by minimising design errors.	Medium
Performance Prediction	Simulates environmental factors to optimise building features.	Improved energy efficiency and material usage.	Energy savings of 15%. Operational cost reduction through enhanced energy modeling.	Low

CONSTRUCTION

These examples highlight the approximate tangible benefits, outcomes, and key metrics associated with integrating AI tools across the design, construction, and operational phases of a building's lifecycle.

Action	Description	Outcome	Benefit	Impact
Project Planning	Optimises schedules and predicts delays using historical data.	Reduced project delays and optimised resources.	25% reduction in project timelines. Cost savings through improved planning efficiency.	Medium
Robotics and Automation in modular construction	AI-powered robots handle repetitive tasks, improving speed and accuracy.	Faster and more accurate construction.	30% increase in construction speed. Cost savings through reduced labor expenses.	High
Quality Control	AI drones inspect sites for defects and compliance.	Improved quality and reduced rework.	20% reduction in rework costs. Also, improved compliance reduces project delays.	Low

OPERATION

The insights are based on referenced use cases or pilot projects involving First Q members. By revisiting the strategic and role-based insights outlined earlier, stakeholders can use this table to identify actionable AI opportunities tailored to their specific needs.

Action	Description	Outcome	Benefit	Impact
Energy Management	Optimises HVAC, lighting, and water use based on real-time data.	Lower energy consumption and operational costs.	15% reduction in utility bills through optimised energy use.	Low
Predictive Maintenance	Monitors systems to predict failures and recommend proactive maintenance.	Extended equipment lifespan and fewer failures.	Reduction in downtime by 30% achieved through predictive maintenance	Medium
Occupant Comfort	Adapts conditions to individual preferences for enhanced productivity.	Improved occupant satisfaction and well-being.	10% increase in occupant satisfaction by personalising conditions efficiently.	High

USE CASE EXAMPLE: AI-DRIVEN HVAC OPTIMISATION IN A COMMERCIAL BUILDING

Considering Figure 5, which highlights HVAC optimisation as one of the AI applications likely to be adopted most rapidly, we will present a specific use case to demonstrate ROI.

In a large commercial office building, the HVAC (Heating, Ventilation, and Air Conditioning) system is a significant contributor to energy consumption and occupant comfort. On average, a commercial building consumes **120 kWh/sqm·year, with HVAC systems accounting for approximately 50% (60 kWh/sqm·year) of this energy use.**

The Challenge: Traditional HVAC systems often operate using static settings and simple schedules, leading to inefficiencies such as overcooling, overheating, or wasted energy during unoccupied periods.

The Solution: AI-enhanced HVAC systems, supported by MEP engineers, dynamically optimise heating and cooling loads based on real-time data, occupancy patterns, and external weather forecasts.

THIS INTEGRATION PROVIDES TANGIBLE BENEFITS:

ENERGY SAVINGS

AI **reduces** total energy use by **15%**
30% reduction in HVAC consumption.

With electricity cost at €0.15 kWh
this equates to 120kWh/sqm annually
× 15% × €0.15 kWh = €2.70 per sqm

Total Annual Savings: €27, 000
for a 10,000 sqm building.

OCCUPANT COMFORT

AI enables adaptive adjustments to heating and cooling, enhancing comfort for building occupants.

While less tangible, this benefit translates into **improved retention rates, reduced sick days, and increased productivity**—all contributing indirectly to financial gains.

MAINTENANCE SAVINGS

Predictive maintenance enabled by AI extends the **life cycle of HVAC systems by 50%**, for example, from **20 years to 30 years**. This reduces the annualised cost of HVAC investments.

If the investment required
every 20 years is €200 per sqm,
the cost is €10 sqm per year.

By **extending the system's** lifespan to
30 years = Annual cost decreases
to €6,60 sqm per year
€3,30 sqm per year savings.

This **reduces the annual cost**
of HVAC investments by **€33,000**
for a 10.000 sqm building.

TOTAL TANGIBLE COST SAVINGS

Combining energy and maintenance savings results in a total €2,7 sqm per year

Energy savings €3,3 sqm per year
Maintenance Savings = €6.00 sqm per year.

For a 10, 000 sqm building, this equates to

Total savings €60,000
€27,000 energy
€33,000 maintenance.

This means that even considering only these tangible savings, the investment in AI-powered HVAC systems is already justified, **offering clear and measurable financial returns.**

Beyond these tangible benefits, the less tangible impacts - such as improved occupant productivity, reduced absenteeism, and enhanced retention - **can significantly amplify the return on investment (ROI).**

These benefits directly affect human capital, which, as highlighted by the 3-30-300 rule (JLL, 2016), delivers the most impressive ROI in real estate investments.

When these intangible advantages are factored in, the potential ROI becomes not only compelling but transformative for businesses aiming to **maximise both efficiency and occupant satisfaction.**

ACTUAL TANGIBLE BENEFITS

OVER 20 YEARS = €1.2M

CONCLUSION AND FUTURE OUTLOOK

The integration of AI in building design and operations, guided by MEP engineering expertise, represents a transformative shift in the built environment. While the benefits are significant, challenges such as the need for consistent data quality, organizational resistance to change, and the evolving nature of AI regulations cannot be overlooked.

Addressing these challenges requires proactive strategies, including fostering cross-disciplinary collaboration, emphasising transparency in AI processes, and continuously refining AI models to adapt to changing needs.

A key advantage of leveraging the First Q Network of MEP engineers, operating across more than 15 countries, lies in the ability to enrich AI tools with high-quality, diverse datasets. This global reach ensures compliance with both international standards and local regulations, which are often overlooked in AI development but are critical for effective implementation in specific regions. The expertise and insights of this network provide a solid foundation for leveraging AI in real estate, ensuring that AI tools are robust, adaptable, and tailored to regional needs.

We're thrilled to present our latest Expert Series from the Smart Buildings Group, designed to inform and inspire. If you're eager to delve deeper into this paper or explore how we can empower your business to adopt transformative technologies and integrate AI tools seamlessly, we're here to engage in meaningful conversation.

Let's connect to chart a course toward AI-driven building resilience and maximise potential together.

FOR MORE INFORMATION email: info@firstqnet.com

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