Digital and sustainable transformation of buildings: increasing efficiency, preserving value

SIEMENS

The environmental impact of buildings today

Humanity today faces a twofold challenge consisting of an energy crisis and a climate emergency. As they are interlinked and reinforce one another, they require action that is all the more urgent.

Charting a path toward a sustainable energy future will require at the same time a reduction of consumption and an increase of efficiency. Given this twin imperative, there is a need to decrease the environmental impact of our lifestyles – including in the built environment, where some of the greatest energy savings and efficiency gains can be achieved.

Currently, buildings account for 40% of global energy consumption, one quarter of which is accrued during the construction phase. They also generate 40% of global CO_2 emissions, of which 27% can be attributed to building operations alone.[1] Clearly, there is a huge savings potential: Worldwide, 80% of commercial floor area is in buildings that are not equipped with any smart technologies, and which therefore start at very low efficiency. Most of them are small and of medium complexity.

A significant share of the data that are generated by or can be derived from buildings and their environments are not used at all. Purely in terms of comfort, convenience, and efficiency, this is a significant omission; but in light of the global energy crisis, it must be regarded as a dramatic deficiency. Importantly, given the age of existing structures and the average lifetime of buildings, all new buildings should already be net-zero.

40% of global energy is consumed by buildings and they generate 40% of global CO_2 emissions.

A huge potential still untapped

Depending on their size, usage, geography, and climatic zones as well as technology, connectivity, and use of data, today's buildings can achieve considerable cost and energy savings. When equipped with appropriate digital solutions potential savings range beetween 30% and 60%.[2]

Naturally, the scope and pathways for optimization depend on the nature of the building and the requirements of the asset owner. Upgrading older buildings that run on legacy software suites and integrating them with state-of-the-art systems is even more challenging than developing entirely new greenfield solutions, with (lack of) connectivity and know-how about operation technology often being the key factors.
What all categories of buildings have in common, however, is the crucial need to become future-proof, especially considering that the global floor area of buildings is set to double by 2060.

80% of commercial floor area is in buildings that are not equipped with smart technologies.

So what exactly are the elements that qualify a building as future-proof? It needs to be flexible enough to adapt to different uses, as the use of buildings may change in response to unpredictable challenges, such as a future pandemic.

It needs to fulfill sustainability requirements, with the goal of becoming net zero – all while constantly balancing tenants' expectations for comfortable, safe, and healthy environments with building owners' need for continuous and cost-effective operations. It is true that this makes for a demanding requirements list. But with the levers provided by digitalization, we now have what it takes to deliver such smart buildings.

Policymakers have responded to the current challenges with environmental, social, and governance (ESG) regulations and incentives that compel building owners and operators to construct and operate their building assets in a smarter and more sustainable manner. One of these is the EU's Energy Performance of Buildings Directive (EPBD). The regulation, which was updated in 2020, is one the main legislative instruments for raising the energy performance of buildings in all EU countries – whether commercial or private. Each EU member state has now transposed the EPBD into their own national law and developed a long-term renovation strategy of its building stock. There are minor variants between member states, but all national laws follow the same main guidelines. The EPBD sets mandatory emission reduction targets and efficiency standards while promoting incentives for renovation of buildings to meet those benchmarks.

In the US, the Inflation Reduction Act[3] of 2022, which places a clear emphasis on growth through incentives, has unlocked massive capital flows, including billions of US dollars for home energy efficiency upgrades and improvements to home energy supply. It also includes an expansion of tax credits designed to foster energy efficiency in the commercial real estate sector.

Emerging tech in the driver's seat

With these regulatory roadmaps in hand, it is up to facility owners and operators as well as investors and owners to set the course for smart buildings. The path will be marked out and smoothened by technological innovations that connect buildings and physical assets with people.

Of course, technology alone cannot solve the challenge of climate change. Government guidlines, individual behavior and tech-driven levers are key elements that facilitate the journey toward a more sustainable, efficient, and cost-effective buildings – i.e., smart buildings.

Smart buildings are typically equipped with systems that ensure automated and optimal operations as well as safety and security.

For instance, pumps are turned off when ice is detected in the water to avoid overpressure and damage to the hydraulic system. Rooms are only cooled when there are people in them.

Room occupancy patterns are learned, and weather forecasts taken into account in order to minimize energy use while still maintaining the occupants' comfort and safety. Equipment data is constantly monitored to detect deviations from normal performance, which allows preventive scheduling of maintenance work.

IoT, Edge and Cloud:
Uses Cases and Benefits

	Use Cases	Benefits
IoT Devices and equipment in buildings come with smart functions and communicate via IP-based protocols.	Use air dampers that send notifications when jammed	Increase indoor air quality
	Use presence detector information to create space usage heat map	Improve space utilization and maintenance
Edge The building automation system is on the edge, i.e., on-premise and connected to the Internet. It runs smart services on-site, at the data source.	Run AI-based fault detection service for HVAC system	Optimize system uptime
	Automatically update device software and certificates	Increase resistance against cybersecurity risks
Cloud Data from multiple buildings is collected and analyzed at scale to derive insights into building performance and optimize it.	Create transparency on energy usage	Meaningful reports available as required per regulations
	Analyze time-series data	Detect and correct anomalies such as unusual energy consumption patterns

When it comes to realizing such functionalities in smart buildings, three technologies are of crucial importance:

1. In building technology, **IoT solutions** consist of devices such as valves, damper actuators, presence detectors, thermostats, etc. that are equipped with smart functions allowing them to communicate via the Internet Protocol (IP), which creates a number of benefits. For instance, a blocked damper can proactively notify the facility manager of obstructions to air flow in a duct.

A fan can predict the end of its own lifetime based on a combination of statistical expectancy and operational data such as vibration impact, which allows operators to avoid equipment failure and downtime through timely maintenance work. IoT sensor data can also provide real-time analytics and optimization services that improve energy efficiency and other key performance indicators (KPIs).

2. **Edge computing** consists of advanced data processing services (e.g., AI, Machine Learning) deployed directly on-site, at the source of building data, while computing nodes can still be connected to the cloud for automatic updates (functionality, IT security), remote access, etc.

One of the advantages of processing data on-premise is low latency and fast response time compared to cloud-based services, which allows for building automation applications to operate without the need to rely on a running Internet connection. Hence, even (safety-)critical automation services including AI-based fault detection in HVAC systems, network intrusion detection, or automation and optimization of laboratories can operate reliably. Furthermore, software can be upgraded overnight and new functionalities added at any time during the entire life cycle of the building.

3. Facilities can be made smarter and more efficient when **cloud-based applications and services** are used to collect and analyze large and distributed amounts of data via a remote and distributed computing infrastructure. This can provide near-infinite amounts of computing power, enough to manage entire fleets of buildings. Such information can be collected across the entire life cycle of a building, starting with data collected during the design and commissioning phase and continuing during servicing and renovating.

This data enables easy engineering, installation, and commissioning and helps owners and operators to optimize the performance and maintenance of their assets, including by enabling remote services. There are plenty of advantages to be derived from the structural acquisition, exchange, and amalgamation of data that is currently siloed across various use phases and domains.

This includes data generated by the building itself, such as automation, HVAC, fire protection, or security, as well as from external sources, such as predictions about meteorological conditions or number of expected visitors. Based on insights gained from this data analysis, buildings can be optimized and their energy efficiency improved automatically for potentially significant cost savings.

Benefits include the ability to leverage advanced services requiring large current and historical datasets to optimize building operations (especially helpful for AI-based services); the capacity to benchmark the performances of large numbers of buildings from a single cloud-based entry point; and the uninterrupted accessibility of the cloud infrastructure from anywhere, which gives customers premium transparency and enables customized solutions that are independent of specific IT platforms.

Advancing to autonomous buildings

Today, just 20% of building floor space is operated using automation solutions, only a fraction of which include smart optimization services. In other words, there is an untapped potential of 80% of building floor space, which would benefit from a facility upgrade with advanced technology to embark on the journey from the traditional to the autonomous building.

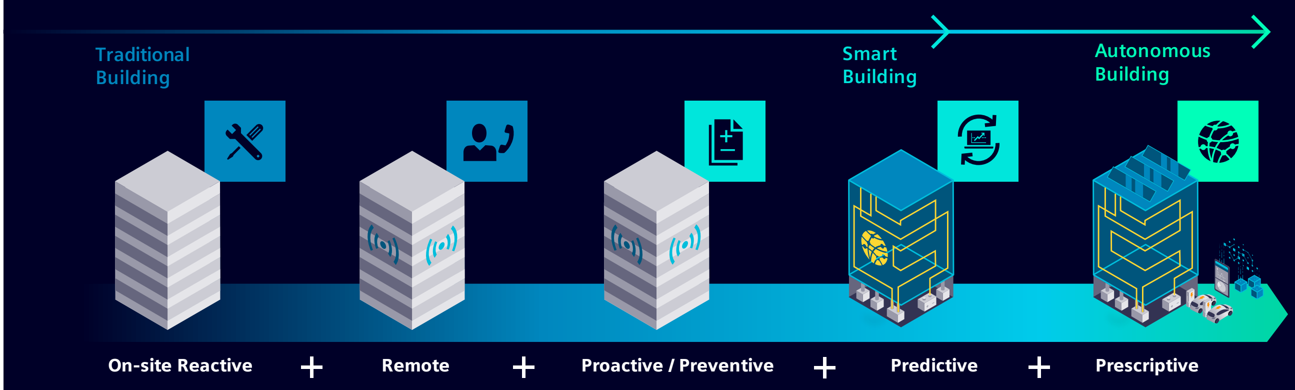
Only 6% of all buildings globally have a floor surface of more than 10,000m^2 and are automated. The other 94% are smaller and the vast majority of those are traditional buildings, which are not automated at all.[4] In those conventional, typically not automated buildings, services are usually performed manually and on-site only. Often, they are strictly reactive in nature and take place in stand-alone systems. As a facility is advanced on the path to a smart building and beyond, each stage helps building operators to identify issues earlier, further reduce system failures, disruptions, downtime, and related costs, prioritize work, improve system performance, increase the life of building systems, and optimize workflows and energy efficiency.

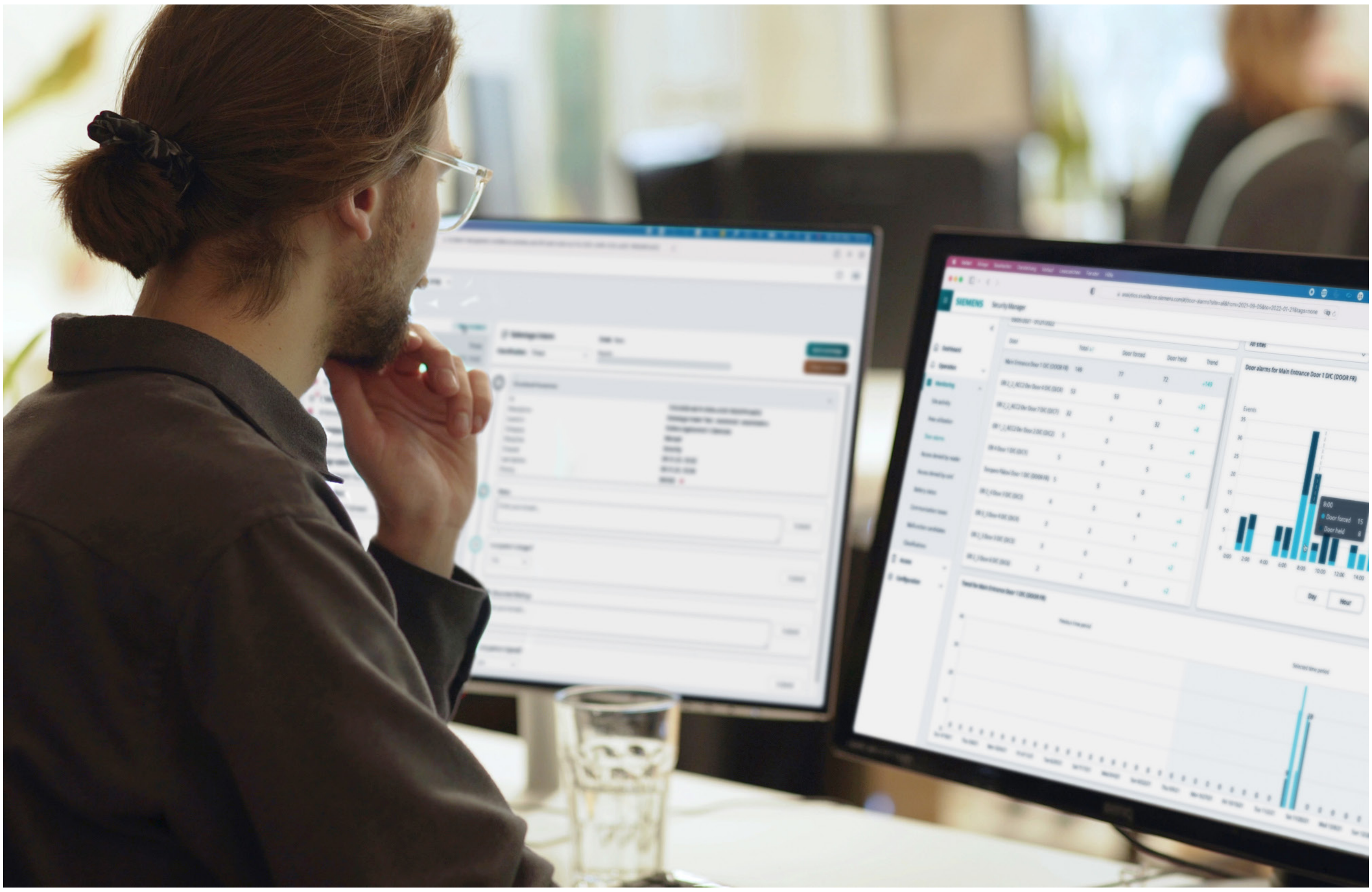
Three steps can take the operator successively closer to reaping the benefits of smart buildings:

- As a first step, the building should be equipped with sensors and automation systems. Isolated building systems are connected and networked in order to overcome silo systems and enable remote monitoring and diagnostics.
- This allows proactive and preventive measures for Fault Detection and Diagnostics (FDD) to be defined and implemented in a second step.
- The third step is the implementation of predictive management, via Machine Learning algorithms that enable autonomous actions. The deep analysis that such predictive services perform can further optimize system performance. Predictive maintenance yields roughly 40% savings compared to reactive maintenance, and predictive analytics offers a tenfold return on investments, resulting in savings of 30% to 40%.

The journey from traditional to smart building and beyond

Pathway to better building performance





Autonomous buildings today

In a truly autonomous building, workflows are integrated, and advanced analytics are not only harnessed to predict failures before they materialize, but also to propose countermeasures. In this way, targeted maintenance can be carried out as needed, assisted by automation features that streamline the process and increase availability by eliminating downtime as far as possible.

Facility owners are supported by this approach, known as prescriptive maintenance, in their efforts to minimize the cost of upkeep, extend the lifetime, and optimize the productivity of their assets. These services can be used to improve performance for individual buildings or for multiple buildings at a time.

If required, digital experts can remotely resolve issues or help prioritize adaptation measures for more efficient and effective use of resources. For example, they can plug into the maintenance management system via Application Programming Interfaces (APIs) and analyze alarms, calls, faults, and maintenance records to identify the root causes of issues, allowing facility operators to focus on the most critical ones.

They are also able to provide work lists based on the specific building portfolio, recommend goals and priorities, and explain the rationale and cost-benefit considerations underlying the suggested prioritization.

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Urgent action required

If humanity is to achieve its goals and prevent global climate change from reaching catastrophic levels, the time to act is now. While the path ahead and its milestones are clearly marked out, the urgency of upgrading buildings and optimizing their energy efficiency has not yet led to commensurate action everywhere.

In order to make this transformation easier and affordable for all, it is important to lower the entry barriers to smart technology for building owners, who face a substantial loss of value over the coming decades unless their assets are upgraded to meet new efficiency standards.

All providers of building technology must work to reduce the inherent complexity of solutions, upgrade processes and accelerate the deployment of modular solutions in order to scale up this vital transformation as quickly as possible.

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Lowering the threshold

A study of 825 organizations conducted by Boston Consulting Group in 2020 confirmed that barriers to digitalization still exist: Only 30% of digital transformations were successful, while 70% failed to meet their targets or to achieve sustainable change in the longer term.[5]

Often, this is because organizations are left to deal with challenges such as lack of scalability, the high effort and cost of integration, and frequent lack of compatibility between solutions by themselves.

In view of the imperative to scale up smart infrastructure and automation solutions to the 80% of buildings that still lack them, Siemens has launched Siemens Xcelerator, an open digital business platform designed to accelerate digital transformation and value creation for organizations of all sizes in industry, buildings, grids, and mobility.

When done right, the deployment of connected hardware and software is an opportunity to be seized – the sooner, the better. For suppliers, that means designing their systems in such a way that they can be easily integrated into their building portfolio.

They can be planned, engineered, and commissioned without the need to involve specialized technicians and experts. In addition, AI and Machine Learning support organizations to select and design the ideal system for their buildings.

This will lower the threshold for adopting advanced optimization services and alleviate concerns over costs, time, and availability of proficient staff. Smart building technologies such as automation or building analytics must also be designed in a way that allows electricians or HVAC technicians to deliver and install them on their own.

Building stakeholders will be more willing to adopt advanced building technology if they are able to reliably calculate the associated savings in advance and without the need for expert input. This is true for both large buildings and for smaller ones. Conversely, Original Equipment Manufacturers (OEM) will find it easier to persuade asset owners to invest capital up-front if there is a clear benefit in terms of lower operating costs in the mid to long-term.

By investing in measures to make buildings future-ready for ESG regulation, investors and owners are preserving or even adding to the value of their real estate portfolio.

Energy Performance Contracts (EPCs) and other dedicated financing service offerings can assuage lingering concerns over capital expenditures, provide assistance with stable financial planning, and give organizations the security of knowing that their investment is a sound one. More generally, by investing in measures to make buildings future-ready for ESG regulation, investors and owners are preserving or even adding to the value of their real estate portfolio, potentially for decades to come.

Keeping building data safe and secure

Security and data privacy

The large-scale collection of data, not only concerning buildings, but also the movements and activities of the people living and working inside them, entails certain compliance issues. Regulations on data privacy, storage, and protection vary depending on the location.

In the EU, the General Data Protection Regulation (GDPR), which entered into force in 2018, governs the collection and handling of personal data, with direct implications for smart buildings. In the US, the rules vary between individual states; other countries and regions have their own regulatory frameworks.

Accordingly, building automation and optimization solutions need to be flexible enough to ensure compliance with local laws.

Another related factor to consider is defense against cyberattacks. The information gathered by building management systems needs to be protected from malicious actors who may try to access the data with the intention of perpetrating privacy violations, blackmail, ransomware attacks, or for other nefarious purposes.

Trends such as the digital revolution and the convergence of IT and OT have brought many benefits and synergies, but they have also created new vulnerabilities for digital enterprises and digitally connected facilities if not protected.

Data storage and processing

The various smart building technologies available offer multiple options for data storage and processing, with implications for data privacy. Data can be stored directly on the premises, which has the advantage of minimizing the risk of man-in-the-middle attacks or other attempts to intercept the transmission of data via external networks that may not be under the control of the rightful data owner.

On-site data storage also allows for quick and reliable access with minimal latency. However, it also requires dedicated infrastructure for data storage and processing to be provided within the facility, which may generate additional costs and increase complexity. Moreover, efficiency gains from the digital integration of a large, distributed building portfolio cannot be fully realized.

Alternatively, building operators can rely on cloud solutions. To name a few of the benefits: building operators have nearly unlimited processing capacity at their disposal without having to maintain their own computing infrastructure and staff; they can manage an entire suite of facilities and enjoy the benefits of economies of scale; they can rely on the uninterrupted availability of their cloud provider, based on Service Level Agreements; and maybe most importantly, the cloud gives them access to the huge amounts of historical data needed for AI solutions and the intelligent optimization services they make possible.

Finally, a hybrid model consisting of cloud services combined with edge computing can be implemented, where information is stored on distributed servers and accessed on demand, while the infrastructure for data processing is kept on the premises.

The trade-off between security considerations, optimization potential, and cost-benefit calculations will be gauged differently by every building owner and operator, depending on their use case, location, specific needs, and business model.

Artificial Intelligence: The fast lane to the future

AI is already part of our daily lives, with some of its applications more visible than others. Examples include smartphone digital voice assistants, autonomous driving, or use in patient care, with the most recent advances in chatbots underscoring the hype. The potential benefits of AI solutions in building management are manifold and can be expected to become part of the mainstream going forward.

In order to ensure that everybody can leverage advantages, AI-based optimization should be scaled up, made accessible and easy to integrate with a plug-and-play approach. This way, it does not require the building operator to spend much time on AI and engage multitudes of IT specialists, software engineers, and data scientists.

Using key technologies to make the most out of AI applications

AI is able to scan, analyze, and optimize data lakes by identifying patterns and recognizing regularities as well as interdependencies and correlations between them. These insights can be used to make complex predictions about building operations and identify optimization potential. AI can also be used to detect and react to irregularities.

Predictive, AI-based management and services allow building operators to keep track of their assets digitally around the clock, continuously monitoring their performance over time. Customized models and Machine Learning algorithms collect, correlate, and analyze data to predict which specific actions will need to be taken, and when.

This optimized maintenance strategy can deliver predictions on when an issue will occur, long before it materializes. As a result, the building will experience fewer disruptions and benefit from optimized maintenance scheduled at suitable service times, which means lower costs for the operator and more convenience for occupants.

To utilize AI to its full extent in the smart building context, it is important that the three technology levers IoT, edge, and cloud work hand in hand:

- IoT devices, being smart and connected, provide massive amounts of data on a continuous basis. This data stream “fuels” the AI mechanisms running on the edge and cloud levels.
- On the edge level, the data provided by IoT devices can be analyzed quickly and without the need for the data to leave the building perimeter. Machine Learning algorithms can be directly evaluated in edge computing nodes, providing insights as to energy efficiency and optimal equipment operations in near real-time.
- On the cloud level, operations that require more computing power and are less critical to have a fast response time can be executed. Energy efficiency benchmarks across an entire fleet of buildings can be conducted.

Examples of self-optimizing building operations

The following examples illustrate how Machine Learning based on self-improving algorithms can enhance building efficiency:

- A predictive cooling service learns that the occupancy of the co-working space on the seventh floor always peaks between 2 p.m. and 3 p.m. Hence, the HVAC system can predictively plan and account for the respective cooling load.
- Operational malfunctions can be diagnosed based on data-driven patterns. E.g., the fact that the room on the tenth floor is too hot can be traced back to the cold-water pump in the basement, which has been manually switched off.
- If the diagnosed issue can be resolved automatically, e.g., by releasing the manual override on the cold-water pump, the smart building – being truly autonomous – can trigger the respective action itself. Should the issue require manual intervention, such as the replacement of the pump, the solution will automatically request or schedule a visit from a service technician.
- Based on the digital twin of a building, an AI-powered service can automatically design and recommend the best building automation solution for the specific building, reducing the need for manual work.

Scaling the deployment and integration of AI in any building

There are several general prerequisites for incorporating AI-based services to make buildings smarter and more efficient. At the most basic level, the available building data must be collected, organized, and managed. This includes construction blueprints, wiring schemes, and operational data as well as information about siloed systems such as HVAC automation, lighting, or access control.

To some extent, this data may already be available in structured form generated by Computer-Aided Design (CAD) tools or Building Information Modeling (BIM) systems. Furthermore, the AI service must be connected to this organized data, which is subsequently augmented by the vast amounts of data points that are continuously generated by the building's operations. This has to be done in a systematic way that serves the unique needs of the individual building and the specific desires and requirements of the operator.

The key challenge is that today, deployment of AI-based services in buildings requires expert know-how at each of the three levels. If the AI-based services are to be scaled up to the point where they can make a meaningful contribution to global climate change mitigation through optimization and efficiency increases, they need to be simplified and made more intuitive.

Edge computing nodes should come with ready-to-use analytics to detect energy inefficiencies as well as malfunctions in equipment.

The IoT devices providing the data needed by these algorithms should be integrated in a plug-and-play manner, where data from IoT devices, such as a fan vibration measurement, is automatically linked to an endpoint of the algorithms.

Moreover, the cloud should always supervise an edge computing node, so that more computationally intensive tasks, such as re-training the algorithms, can be offloaded into the cloud. All of this should be done automatically, without the need for expert input.

Ideally, one should not have to be a computer scientist to carry out these steps or to gain actionable insights from the processed data. Any facility manager, electrician, or even the end users themselves should be able to deploy an AI-based service in the building whose performance they wish to optimize.

Scalable digital building platforms

What is needed are user-friendly, holistic, and open platforms that support data-driven applications and connectivity solutions where complexity is hidden from the user and actions are automated as far as possible. Ultimately, the algorithms that optimize automation and processes should make the buildings fully autonomous and help them learn to become adaptive to the needs of users with minimal human intervention.

One such platform is Building X, a scalable digital building platform to digitalize, manage, and optimize building operations, allowing for an enhanced user experience, increased performance, and improved sustainability.

The main advantage of having a platform such as Building X is it supports users to make intelligent decisions about their building or fleet of buildings. It is modular, fully cloud-based, with AI-enabled applications, strong connectivity and built-in cybersecurity. This contributes to creating a seamless experience for users across different applications, whether they are related to energy management, security or building operations. It also paves the way to fully autonomous buildings that continuously learn from and adapt to the needs of their tenants.

Platform applications and their benefits for building managers

Today, people in charge of running and managing buildings face numerous tasks and challenges. Data is the very basis for addressing those challenges and optimizing building performance.

Building X makes data accessible to all stakeholders under one user interface, and the suite of applications puts an end to formerly isolated
data silos.

This approach supports building managers' needs and helps them reach their business goals:

- A sustainability manager will aim to improve the energy performance of their buildings based on real-time data and meet emissions targets. With AI-based analytics, they can prevent budget overruns.
- A facility manager who operates individual or multiple sites can use Building X tools to improve operational efficiency by minimizing resource consumption and costs over time. Via remote access to control and management systems, they can handle troubleshooting from a single location.
- A security manager will want to bring down the cost of security management, reduce the risk and severity of incidents to create a secure environment for their workforce, and deploy their security personnel efficiently to ward off physical intrusions and cyberattacks alike.
- A real estate manager can use Building X to compile finance or HR reports, ensure business continuity, and procure sufficient space at the right time for the right price.
- IT managers need to manage API access and usage, facilitate secure data exchange, and ensure their IT suite is fit for purpose and also cost-efficient. Smart solutions help them ensure their IT systems are both secure and future-proof.
- An application engineer will aim to accelerate the design, development, and testing of new apps and service models, and to combine building data and data from other vendors in applications and collaborate with internal and external developers.
- A fire manager requires advanced protection systems that ensure the physical safety of building occupants and their work environment by providing detection, alerting, and evacuation systems as well as advanced solutions for fire extinguishing.

Powering next-generation Building Services with Building X

Adding building services on top of a digital building platform enables building operators to benefit from end-to-end service programs which further reduce operational and energy costs, while getting closer to their sustainability goals.

When applied with an outcome-oriented approach, digital services can be tailored and scaled to deliver results for specific goals and use cases, creating benefits to building owners and operators across five key value pillars:

- **Helping meet regulatory requirements** through improved compliance with building sustainability and cybersecurity standards.
- **Enhancing the occupant experience** with safety, comfort and environmental features that drive productivity and wellbeing.
- **Cutting costs** by reducing OPEX, capital requirements, maintenance costs and energy use.
- **Driving revenue and growth** by optimizing space and safeguarding business continuity.
- **Optimizing performance** by improving the uptime of assets and productivity of people.

Digital services harness the power of data to drive long-term programs for decarbonization, energy and cost reduction, and occupant experience across a range of infrastructure, from single buildings to university campuses, hospitals, manufacturing sites and businesses with global real estate portfolios.

Data-driven maintenance models are a good example, in which digital services for asset management enhance the performance of assets, using data analytics to extend the life of equipment, reduce unplanned downtime, and improve performance through continuous monitoring, while allowing businesses to focus on their core competence.

The digital services approach is evident in projects all around the world. Siemens has been working with the Sello shopping center in Helsinki, Finland, for more than 20 years to improve the visitor experience, reduce its carbon footprint, drive operational efficiency, and shareholder value.

The result is one of Europe’s smartest buildings, which has achieved 92% in the Smart Readiness Indicator and delivers annual savings from ongoing energy, maintenance, flexibility and investment solutions of almost EUR550,000. As a result of the partnership, it also sees significant reductions in energy use and CO_2 emissions, and annual gains in the flexibility market – as a result of a virtual power plant – of some EUR350,000.

Software for smarter assets

An occupant's experience with a building is only as good as the maintenance of assets that provide comfort, safety, and security. Maintaining modern buildings has become increasingly complex. Not only has the volume of assets grown but the sophistication and variety of these assets has evolved.

Additionally, building managers must meet new regulatory standards related to preventative maintenance and compliance. Also due to growing operational complexity, they are tasked with reducing operational costs and minimizing new capital expenditures. The tools used in this environment are often outdated, siloed, or both.

Progressive building managers are embracing new technology to meet the challenge of modern asset management and maintenance. Building a unified, digital view of their assets provides the foundation to realize true operational efficiency. Technicians are able to utilize cloud-based applications to manage workflow efficiently, all connected to a single data set that updates in real time as work is performed. Managers are able to leverage analytics to plan, and budget based on predictive, data-driven insights.

It has become increasingly important to improve efficiency and reduce costs while maintaining high standards of safety, comfort, and sustainability for building operators. A cloud-based software platform is able to leverage data and deliver predictive insights. These guide users through the entire asset life cycle.

From day-to-day maintenance of critical assets to strategic planning, software solutions can help building managers with every aspect of maintenance and operations. Here are some of the benefits operators can expect:

Seeing the full picture: The ability to manage and maintain all assets – no matter where they are – in one unified application for better visibility throughout the organization.

Streamlining maintenance: Increasing efficiency with easy-to-use software to create, track, and manage work orders while enabling the field with connected, cloud-based tools.

Proactively maintaining assets: Extending the life of physical assets with automated, preventive maintenance schedules to reduce costs and maintain operational efficiency.

Monitoring critical assets: Identifying and maintaining poorly performing assets with IoT remote asset management and automatically generating work orders to minimize downtime.

Making smarter decisions: Obtaining a 360-degree view of operations and using built-in analytics to make data-driven operations and budget decisions.

Remaining compliant: Leveraging tools for risk assessments, preventive maintenance workflows and compliance code tracking to ensure regulatory compliance.

Conclusions

Overcoming the fundamental challenges of our time – like climate change and the energy crisis – will require a substantial contribution from the building sector that can only be achieved by making buildings smarter and more autonomous. On this journey, the three key technologies that will pave the way are IoT solutions, edge computing, and cloud-based applications and services.

The main obstacle to widespread introduction of these technologies in buildings today is their complexity, which means that installing and operating them requires considerable expertise – especially when state-of-the-art digital packages must be integrated with older and sometimes obsolete IT suites.

By reducing this complexity and making solutions easier to use, we can accelerate their uptake. All three of these technologies are enablers of AI, supplying a steady stream of data for analysis, either on location or in the cloud, to optimize the performance and efficiency of individual assets or entire building portfolios.

Currently unused data generated by buildings should be captured, pooled, analyzed, and harnessed in a scalable form. Going forward, this will make it increasingly easy to deploy self-improving algorithms at scale and harness the potential of digitalization to make buildings ready for the future.

Overcoming the challenges of climate change and the energy crisis will require a substantial contribution from the building sector that can only be achieved by making buildings smarter.

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