Building Meets
Artificial Intelligence

SIEMENS

ARTIFICIAL INTELLIGENCE

Introduction

Such statements such as ‘data is the new oil’ and ’success in creating effective artificial intelligence (AI) could be the biggest event in the history of our civilization.’ [1] have been around for a while now.

There’s truth in both - but it warrants diving deeper and exploring AI from more perspectives. Because while AI brings enormous opportunities and will undoubtedly improve people’s lives dramatically, tapping into its full potential still presents several challenges. Particularly when connecting and mapping technology within buildings.

Software engineers and data scientists have created AI-enabled applications, platforms, and connectivity for buildings. The goal? To decarbonize the planet and people’s sustainability performance, tenant experience, safety and comfort, as well as overall building efficiency.

The topic of AI often causes a split in opinion: one side believe that it will revolutionize our world and make human life easier, and the other that it will lead to unethical decisions or replacement of humans.

Advocates of AI argue that, for instance, AI-driven autonomous cars will substantially reduce the annual death count of 1.25 million people in car accidents [2]. Furthermore, personal assistants such as Apple’s Siri or Amazon’s Alexa will help organize our continuously accelerating lives, and doctors will be able to make faster, more precise medical diagnoses [3].

Conversely, there is the fear that AI will help create new chemical weapons [4] or automate low-skilled jobs, resulting in a substantial increase in unemployment and frustration in society. At the beginning of the COVID-19 pandemic, such a scenario was drawn frequently. Two years later, economists are now revising their views on jobs and robots [5, 6].

Another line of argument is that the increase in surveillance over individuals can easily be abused. For instance, AI-powered cameras could recognize humans and track them throughout the day, or hackers could utilize AI-driven algorithms to launch cyber-attacks or steal corporate secrets.

CHAPTER 2

How can **AI optimize buildings?**

As of today, '127 new devices connect to the internet every second' [7], generating enormous amounts of data that can power AI-based products. But what is the role that AI can play in the sector of buildings, and why is the adoption of AI in buildings trailing behind other industries - when humans spend roughly 90% of their time indoors?

What is AI?

Before answering those questions, one has to understand what AI is, beyond a buzzword. Artificial Intelligence is a capability that enables computers to mimic human intelligence to perform intelligent tasks such as reasoning, decision making, or interpreting human interactions. One of the subsets of AI is machine learning (ML).

Mapping these capabilities to the opportunities in buildings is the next step. Buildings of all kind already generate substantial amounts of data. Starting with the construction phase, all sorts of plans are created and used. In the more modern era, tools such as computer-aided design (CAD) and building information modeling (BIM) are widely used to cope with data complexity.

Once buildings are in the operations phase, this data is extended with sensors, actuators, controllers, wireless LAN logs, access control logs, maintenance data, and much more. In the past, this data used to be stored separately and isolated with limited access and, therefore, a substantial hurdle to utilize it beyond the original purpose. However, with the rise of the internet of things (IoT),

It allows computers to achieve such behavior by learning from data. For instance, self-driving cars mimic human intelligence to decide which lane to drive in or to reason whether another car might pose a danger. To achieve this, developers of such cars let them drive millions of miles in predefined scenarios on test tracks to collect and use data to learn how to drive safely.

internet connectivity, and open standards, these hurdles began to disappear while also unlocking substantial opportunities.

For instance, in the domain of efficient energy management and decarbonization, 40% of global energy consumption can be linked directly to buildings [8]. With increasing regulatory and societal pressure to improve, business and cost-saving opportunities arise. By benefiting from unlocked data, AI-driven algorithms can detect inefficiently running equipment, and optimize energy usage based on occupancy and other external factors, eventually reducing overall CO_2 emissions. AI can also optimize operations costs by automatically deciding when to purchase energy from utility providers based on demand and price predictions.

All this sounds straightforward and obvious, so why has it not been done already? If not utilizing AI, solutions to manage energy efficiently typically require a well-designed control system created during the construction or retrofitting phase. The challenge is that buildings are often used in ways that were not fully anticipated upfront and are subject to dynamics, such as a fluctuation of tenants, surrounding areas,changes in space utilization, or simply weather conditions.

To cope with these challenges, manual labor is utilized, which is expensive and unscalable. This means that typically only large and premium buildings can afford such solutions. With AI-driven solutions, most of these challenges disappear. Data can be utilized to learn the exact usage patterns of buildings and deploy tailored, affordable optimization solutions with nearly no humans in the loop.

According to several studies, for every dollar spent on energy consumption in office buildings, employers spend $100 on each employee working there [9]. Hence, it's clear that ensuring an appropriate level of comfort to maximize productivity and minimize potential causes of sickness is vital for businesses. This demonstrates another high-profile area in which AI-driven solutions aim to generate substantial value.

Anybody who's ever shared an office will understand that there is no perfect temperature or lighting condition. It's no surprise either, then, that around 90% of comfort complaints to facility management are of being too hot or cold. This might result in situations where one person turns the heating to the maximum level while another person – sitting just a few meters away – opens a window to cool down. Needless to say, this has significant consequences on energy consumption.

Thanks to the installation of HVAC equipment in buildings, combined with data collected from tenants such as office workers. AI-driven solutions can learn personal preferences and observe context, such as weather conditions, to autonomously find thresholds for comfort to maximize productivity and reduce tenant complaints.

Regardless of how smart a building is, there will always be the need for humans to repair equipment, clean areas, or perform mandated manual inspections. Nevertheless, AI-driven solutions can substantially optimize these processes as well.

Several years ago, shipping company UPS, among others, started utilizing data to optimize delivery routes, resulting in a reduction of left turns of their vans, which substantially contribute to delivery time [10].

Similar approaches can be used by facility cleaning companies. For instance, information about the occupancy of each building area throughout the day can be used by AI-driven solutions to calculate an optimum cleaning plan, including an indication of what extent each of the areas needs to be cleaned.

Challenges and **Siemens' answer**

Given all these opportunities to improve the lives of multiple stakeholders, why is the building domain trailing behind other industries in adopting and utilizing AI?

There are three significant challenges:

1. collecting, organizing, and managing data
2. upscaling the deployment of smart building solutions
3. dealing with the complexity and uniqueness of buildings

Siemens addresses these challenges with its brand-new offering: Building X.

Building X is a holistic, open platform of data-driven applications and connectivity solutions for buildings during the operations phase. The platform is based on extendable business services and a common data model that provides a single source of truth for a digital building.

It addresses the first challenge in several ways. First, Building X offers a range of connectivity options to extract data from different sources in buildings and provide unified access to it through a standardized application programming interface (API) layer.

Data is not only continuously generated, e.g. by sensors, but also through one-time activities, such as construction, maintenance, or retrofit activities.

Throughout a building's lifecycle, much of this information is lost. Thankfully, Siemens brings the Ecodomus solution [11] which can act as a common data environment for any building-related information. Beyond giving a holistic view of all this information, it also opens AI-driven solution possibilities to observe patterns and lead to further optimization.

The second challenge is upscaling the deployment of smart solutions. As of now, connecting a building to access different data types is a manual and labor-intense process. For example, a medium-sized building can easily have several thousand data points, such as temperature values, setpoints, or configurations. Furthermore, they usually come with cryptical names which need to be manually parsed and brought into a semantic relationship to be usable by AI-driven solutions, such as ‘this is a temperature sensor delivering values in Celsius from room 33 in building 32 that can be changed by the setpoint X’.

Building X includes several intuitive applications that speed up the process of connecting and digitizing buildings with a sophisticated user experience (UX) design, bulk operations, and AI-driven semantic enrichment capabilities.

Once buildings are connected and digitized, the third challenge needs to be addressed: generating insights from data. Today, highly-trained experts crunch the numbers from dozens of graphs. In the future, as more and more buildings will become smarter, the ratio of these highly-trained experts will decline [12], causing a bottleneck in getting the most out of smart buildings.

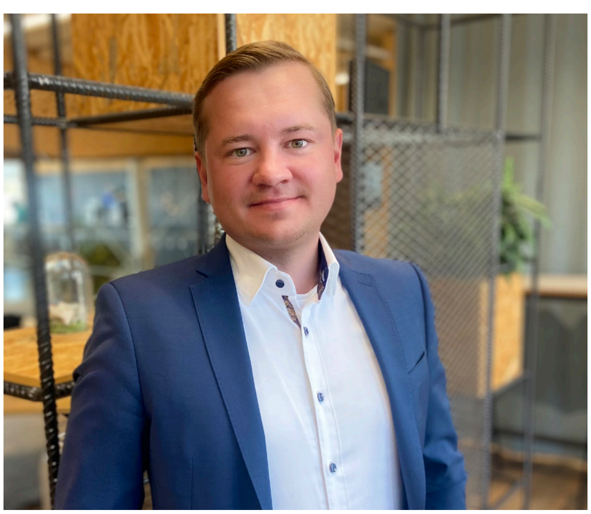
Building X addresses this challenge in multiple ways. It starts with domain-tailored, user-facing applications that allow people to focus on what matters to them by hiding complexity and automating actions. Then, by enriching these applications with AI-driven algorithms, such as forecasting or anomaly detection, insights are generated automatically and presented clearly.

Furthermore, optimization algorithms can empower buildings to become autonomous, i.e., self-learning and self-adaptive, with limited human intervention. Beyond that, expert users can use Building X analytics environments such as rules and Machine Learning to create smart solutions tailored to their needs and the needs of their customers.

There’s no doubt that smart and autonomous buildings are the future. They can substantially contribute to solving some of society’s most pressing issues as well as unleash an untapped range of business opportunities. Siemens Building X is the vehicle for this future.

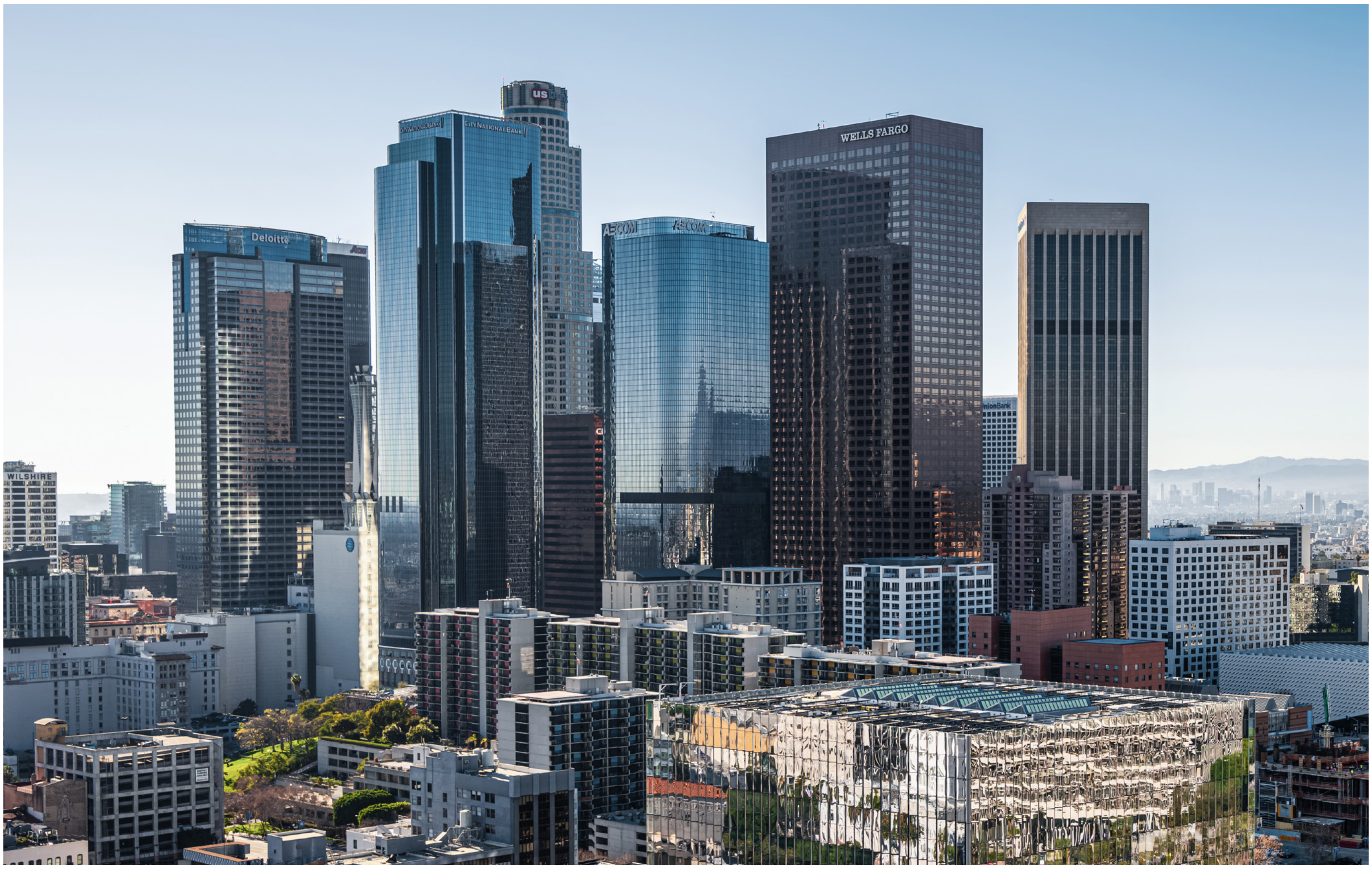
It’s only the beginning of the journey where AI will help make buildings more sustainable and more efficient, to create environments that care. The examples discussed in this article are just the tip of the iceberg. Some are more futuristic, while others are just around the corner. I hope they have sparked some inspiration and new knowledge for you.

To see what Building X can do for your smart buildings, visit: **usa.siemens.com/buildingx**



About the Author

As Global Head of Product Management Data Analytics at Siemens Digital Buildings, Dr. Paul Baumann’s mission is to make buildings smart and autonomous by utilizing the data they generate. Prior to his current position, Paul worked as a Product Manager for IoT devices and building automation. He holds a Ph.D. from TU Dresden in Data Analytics and an M.Sc. in Computer Science from TU Darmstadt, Germany.



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