How Digital Twins Empower Cities and Engage Citizens

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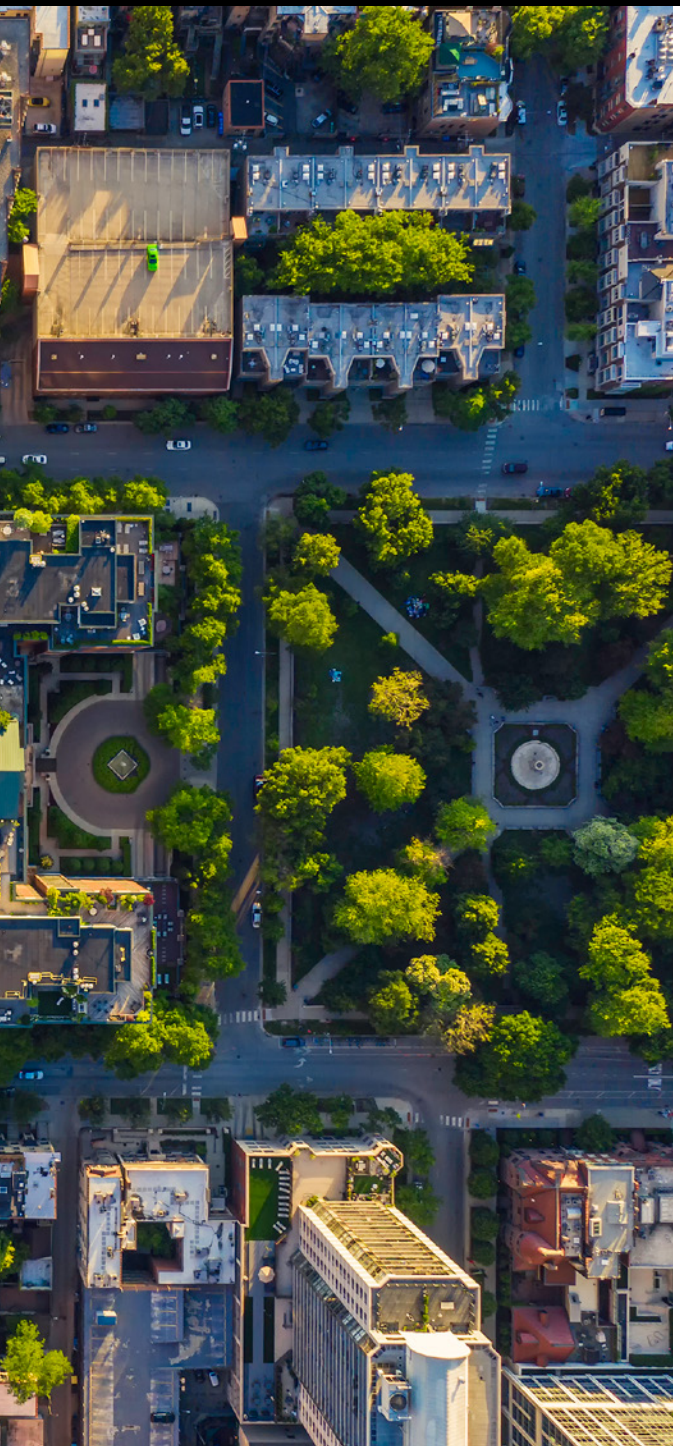

City leaders face a daunting menu of challenges and opportunities. For example, upgrading aging infrastructure that provides a critical foundation for resilience and safety is a top objective. The American Society of Civil Engineers (ASCE) recently released an infrastructure report card for the U.S. ASCE described the nation's water infrastructure as "aging and underfunded," and reached similar conclusions about energy and transit infrastructure.

Rapid urban population growth puts even more pressure on the infrastructure cities need to deliver essential services while pushing cities to optimize available space to fully accommodate new citizens. According to the United Nations, 55% of the world's population lives in urban areas. By 2050, nearly 70% of global citizens are expected to live in cities, drawn by job, educational, and cultural opportunities.

These challenges also represent important opportunities to modernize urban infrastructure with the input of citizens in ways that improve lives and enhance public trust and confidence in local government. Elected officials, urban planners, digital innovation leaders, and their partners must seize this opportunity by building new infrastructure and upgrading aging systems that ensure safety and allow citizens to thrive. This involves everything from cultivating an attractive business environment and good schools to ensuring affordable housing and ample green space for recreation.

None of this is easy. Factors far beyond the control of city leaders—like inflation and climate change—often dictate the severity of the challenges leaders must navigate. Nevertheless, city leaders must embrace innovative and impactful solutions to improve infrastructure, the environment, quality of life, and the economy, and do so with perpetually overstretched budgets. By leveraging uniquely powerful tools, such as digital twins, cities can foster the input, experience, and support of citizens they are committed to serve.

A Trust Gap Between Cities and Citizens

Arguably, one of the biggest challenges that city leaders face is a lack of trust. Citizens increasingly question whether institutions, including city governments, provide meaningful value to their lives. In fact, the most recent Edelman Trust Barometer eveals citizens' negative attitudes toward businesses, media, non-governmental organizations (NGOs), and governments.

Edelman interviewed 33,000 people in 28 countries and found that 61% have a moderate or high sense of grievance against government, business and wealthy individuals. Edelman defines grievance as citizens' belief that institutions make their lives harder and focus on serving the interests of the rich.

Citizens are especially disdainful of the government. For example, nearly 70% of those interviewed by Edelman believe government leaders purposely mislead people by saying things that they know are false or gross exaggerations. Not surprisingly, distrust of government leaders leads to low levels of civic engagement. According to an AmeriCorps report released at the end of 2024, just 9% of Americans attended local school board or city council meetings in 2023.

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Source: Edelman Trust Barometer

Transparency and Clear Communication: The Foundation of Trust

Citizen support and understanding of city investments in new housing, transportation infrastructure, parks, and other projects are critical to their funding and efficient completion. But the good news is that encouraging citizen engagement and building trust is both possible and already happening.

An effective strategy to foster trust is to modernize the tools and processes that cities employ to communicate their civic vision, explain how individual projects contribute to that vision, and provide regular updates on project progress. In far too many cities, communication about projects often remains inconsistent, non-existent, or arrives in indecipherable formats. For example, cities shouldn't force citizens to read technical and confusing blueprints or decipher abstract renderings to understand and provide feedback on proposed projects.

"Trust is extremely crucial when it comes to the successful completion of infrastructure projects," said Dorothea Manou, solution manager, cities and urban infrastructure for Bentley, a software company that provides infrastructure engineering solutions for designing, constructing, and operating roads, bridges, utilities, buildings, and other infrastructure. "We are trying to emphasize that it is really important to have transparency when cities talk about project planning and execution. When citizens don't understand what is happening with infrastructure projects and feel like there are barriers preventing their input and participation, that breeds distrust."

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But what tools are available to cities, communities, municipalities, regions, and other local governments to communicate project plans and progress clearly? Increasingly, large and small cities—from Dublin, Ireland (learn more), and Singapore to Perry, Iowa (learn more), and Pau, France (learn more)—are leveraging the unique capabilities of digital twins to develop projects, solicit citizen feedback and build them quickly.

A digital twin is a realistic and dynamic representation of a physical asset, system or city. It can be continuously updated with data—including engineering, geospatial, Internet of Things (IoT), and other inputs—to represent the current state, model performance, or predict future conditions.

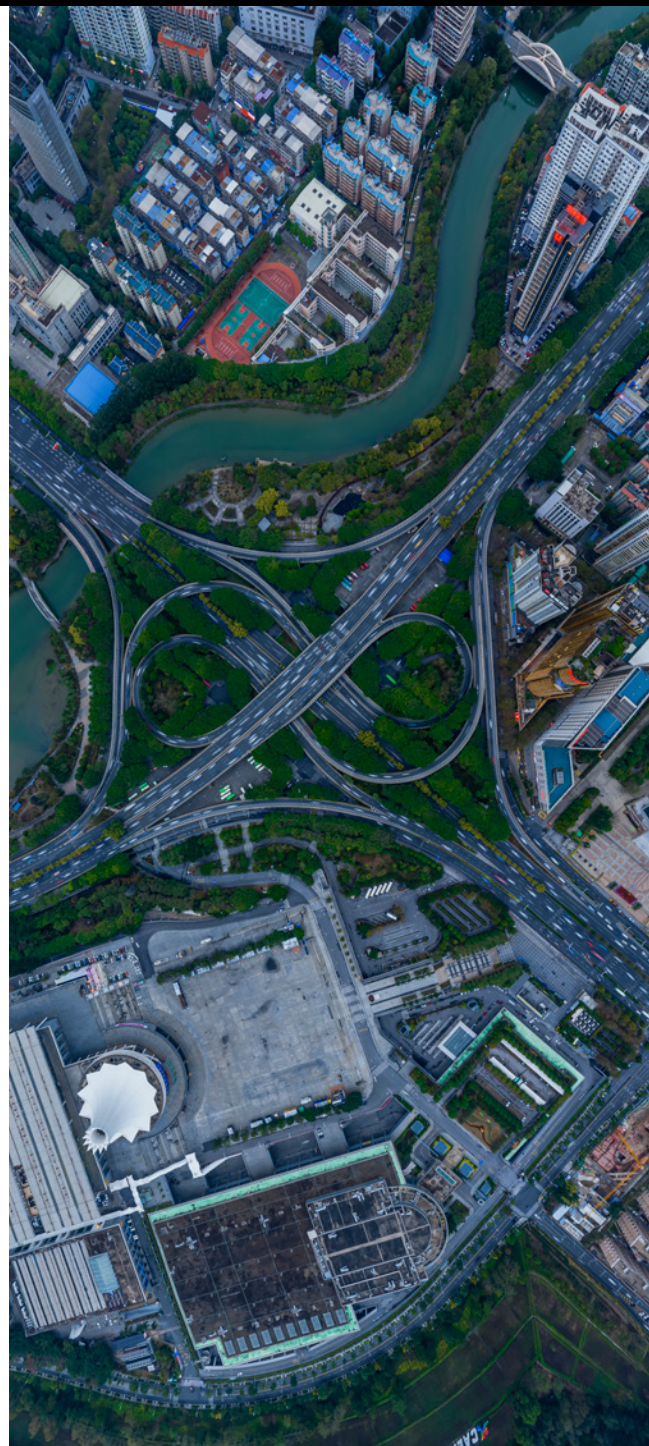
In sharp contrast to technical documents and drawings, digital twins provide a relatable and engaging view of the physical world that helps citizens fully comprehend what proposed projects will look like and how they relate to an existing cityscape. “It’s more interactive. It’s user friendly,” Manou said. “It allows citizens to view and understand complex data and models in a more comprehensive environment. For citizens, it’s easier to grasp all the project plans and the development and the progress of a project.” Clear communication and, importantly, the opportunity to shape new infrastructure encourage public engagement and support.

Building Digital Twins: An Accessible Process

Global adoption and familiarity with digital twins vary. Cities in some countries—especially Nordic nations and Australia and New Zealand—routinely use digital twins as tools for fostering project collaboration and citizen engagement. Cities in other nations are less aware of the benefits digital twins provide, and some assume they lack sufficient data to construct an accurate and valuable digital representation of their city.

Data concerns should not deter any city from pursuing the benefits of digital twins. "By default, we offer basic map data sets that you can use as a background. Cities can use open sources in a lot of regions and areas globally," Manou said. "You start with that and then you build piece by piece." For example, open-source data includes geospatial and mapping data from NASA, Copernicus, and the U.S. Geological Survey (USGS); remote sensing data from the National Oceanic and Atmospheric Administration (NOAA); and existing infrastructure and asset data assembled and maintained by regions, cities and nations.

Additional project-specific data can be added to digital twins to provide a dynamic and continuously improving real-world representation of physical infrastructure. This data includes 3D models and design files, along with visual representations of a project's before-and-after impact. "This is how you can create an interactive digital twin that you can enhance with 3D models," Manou said. "You can then simulate various scenarios in the virtual world before executing in the physical world. This is a powerful tool for educating and engaging the public about infrastructure projects."



AI Workflows: Boosting Efficiency and Accelerating Timelines

One source of public frustration is the feeling that infrastructure projects take far too long to complete. In some cases, delays result from overextended designers not having enough time to work on individual projects. “Nowadays, the demand for civil site development projects exceeds the number of qualified site civil engineers and designers,” Manou said.

AI can help address these challenges. AI-supported design tools are emerging that serve as intelligent assistants to engineers and designers. For example, an AI co-pilot by Bentley analyzes huge amounts of design data, can propose preliminary designs following specific guidance from a designer and can suggest improvements to existing designs. The co-pilot can rapidly iterate through design alternatives, identify potential clashes or inefficiencies, and help predict performance before any physical work begins.

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-Dorothea Manou, Solution Manager, Cities and Urban Infrastructure, Bentley

For digital twins, this means that the virtual models are populated with highly optimized, data-driven design information from the very outset. As a project progresses, the co-pilot can continuously refine the digital twin’s design components, ensuring that the virtual representation remains a precise reflection of the intended or evolving infrastructure project, which is important for transparent communication and engagement with citizens.

Another AI workflow that enhances the value of digital twins involves real-time road analysis tools. For example, Bentley’s real-time road analysis tool uses sensors and data feeds from physical infrastructure to provide immediate insights into road conditions, such as traffic flow, incident detection and pavement conditions. Cities can stream real-time data into a digital twin, enhancing the virtual model’s representation of the physical world. This can help inform the public about a proposed project. But it can also be a tool that improves the quality of life of citizens by identifying when roads need maintenance and incident response.

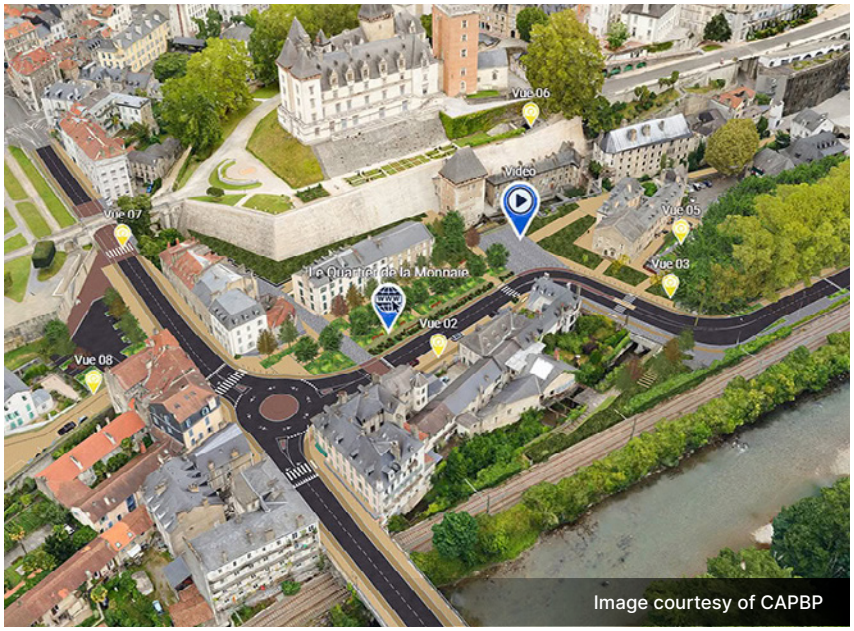
Bridging the Trust Gap with Digital Twins

Digital twins enhanced with AI workflows are powerful, innovative tools. But their real value to cities is not the advanced capabilities they provide; instead, digital twins are valuable because they improve the quality-of-life citizens enjoy thanks to modernized and optimized infrastructure. By elevating quality-of-life and proactively and clearly communicating with citizens, cities also build trust.

For example, the Communauté d'Agglomération de Pau Béarn Pyrénées (CAPBP) in France used a digital twin to overcome the challenge of communicating a complex regional renovation plan to its citizens. Initially, CAPBP used a digital twin to improve the city center by introducing cycle paths to reduce traffic congestion and pollution. But that original digital twin use case expanded to include visualizing utilities both above and below ground, incorporating building information modeling (BIM) with detailed asset information, as well as connecting IoT sensors for real-time insights into various city systems.

This enhanced digital twin allowed CAPBP to provide complete and up-to-date information to technical, political and citizen stakeholders alike. The result: citizens could easily provide feedback on urban planning development projects through an interactive 3D model.

"The digital twin transformed abstract plans into relatable 3D visualizations and empowered community members to understand and engage with decisions about their city's future," Manou said. The city's mayor and his cabinet also used the digital twin to inform urban planning discussions.



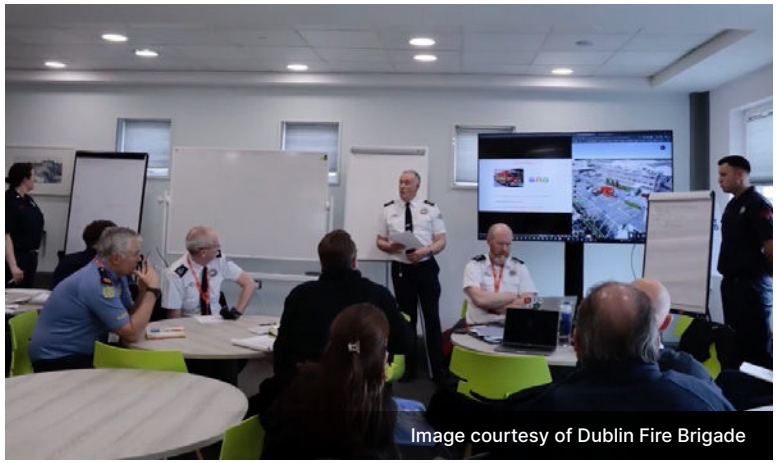
Multipurpose urban digital twin of Communaute d'Agglomeration de Pau Bearn Pyrenees.

Using a digital twin as a single source of truth for information about infrastructure projects saved the city money. For example, providing city workers and contractors access to access data directly from the digital twin rather than from individual city departments led to a 95% reduction in information access costs. CAPBP also saves EUR 200,000 annually by eliminating the need for costly external video productions to communicate project details.

The city of Perry, Iowa, a rural town of just under 8,000 people, initially used a digital twin for the Americans with Disabilities Act (ADA) compliance. However, the city realized that having a comprehensive digital replica of the entire town—including roads, buildings, and sidewalks—provided a helpful blueprint for future development, disaster preparedness, and effective dispatch of emergency vehicles. Though direct public engagement and transparent communication weren't the original motivation for using a digital twin, the city found that having an accessible dataset inherently builds citizen trust by improving the city's ability to plan proactively and respond to crises, like the Derecho storm that hit the city in August 2020.

Digital twins can also bolster trust in local government by enhancing public safety. The Dublin Fire Brigade (DFB) in Ireland, for instance, implemented a Digital Twin for Emergency Response (DTER) to reduce pre-incident planning (PIP) time.

A digital twin of an Iowa town illustrates the future of American infrastructure.



Digital twin for Emergency Response (DTER), Dublin Fire Brigade (DFB) in Ireland.

The 3D model of complex infrastructure allows firefighters to quickly access critical, actionable data in emergencies. It's information that helps emergency responders respond quickly and minimize damage to property and, most importantly, save lives. When citizens see emergency services operating efficiently and capably, trust in the competence of government is reinforced.

By offering a transparent, interactive window into urban planning and operations, these technologies empower citizens with knowledge and a voice, shifting them from passive recipients of decisions to active participants in shaping their communities. This fundamental change aligns with the core purpose of governance: to serve and improve the lives of its people. "Cities can communicate their plans better, but also citizens feel more engaged and part of what is being created for them," Manou said.

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> -Dorothea Manou, Solution Manager, Cities and Urban Infrastructure, Bentley

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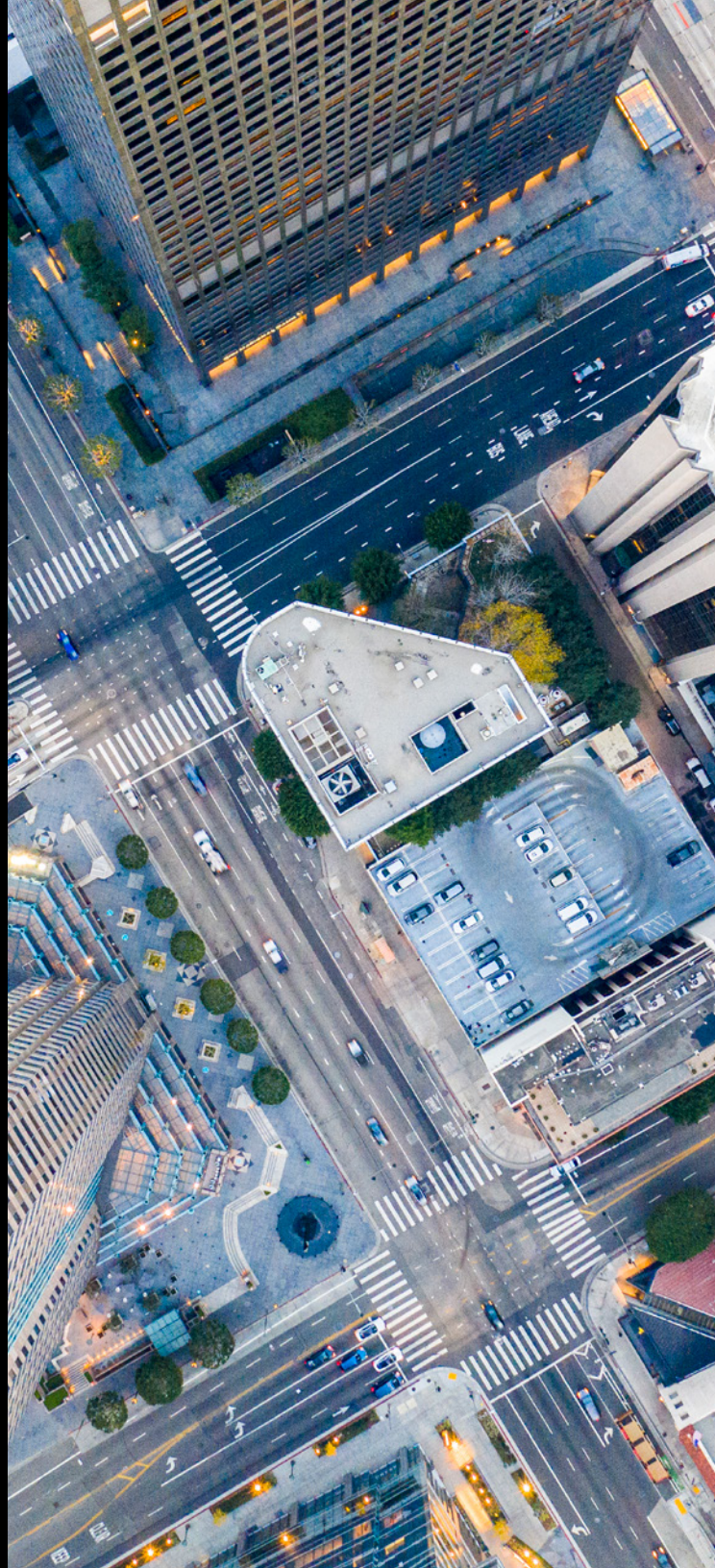
About Bentley

Around the world, infrastructure professionals rely on software from Bentley to help them design, build, and operate better and more resilient infrastructure for transportation, water, energy, cities, and more. Founded in 1984 by engineers for engineers, Bentley is the partner of choice for engineering firms and owner-operators worldwide, with software that spans engineering disciplines, industry sectors, and all phases of the infrastructure lifecycle. Through our digital twin solutions, we help infrastructure professionals unlock the value of their data to transform project delivery and asset performance.

Learn more



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