



PAS MEMO

Planning for Digital Twin Implementation

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Planners today face a complex landscape of social, environmental, and economic challenges. These challenges underscore the pressing need for innovative solutions to address immediate problems and foster resilient, thriving urban ecosystems for the future. Amid these demands, emerging technologies offer new possibilities for planners. One tool with significant potential to change planning practice is digital twin technology.

A digital twin creates a dynamic virtual representation of physical environments, blending disparate datasets with advanced modeling and simulation capabilities (Figure 1). This means planners can visualize urban systems, test scenarios, and predict outcomes with high levels of accuracy and depth. Digital twin technology not only offers planners a robust set of tools for tackling some of the most critical challenges facing our communities, but it can also help transform approaches to problem-solving and decision-making. Digital twins enable planners to transition from reactive adjustments to proactive strategies, laying a solid foundation for sustainable, data-driven urban development.



Figure 1. Digital twins create a dynamic virtual representation of physical environments, blending disparate datasets with advanced modeling and simulation capabilities (image courtesy Giraffe)

Establishing a digital twin may seem complex, but with a thoughtful and structured approach guided by a strategy, it becomes achievable. Planners can set themselves up for success by clearly defining their needs, understanding the value a digital twin can deliver, and outlining a practical roadmap for implementation. Taking the time to plan deliberately can help ensure a digital twin program is purposeful, aligned with organizational goals, and grounded in real-world capabilities.

This *PAS Memo* provides planners with actionable guidance on how to create a strategic framework for digital twin development. It begins by defining digital twins and explaining how planners can leverage this robust tool to enhance decision-making, operational efficiency, and stakeholder engagement. It then offers structured strategies and practical insights to help planners successfully plan, prepare for, procure, and implement digital twin systems that address complex challenges and create long-lasting value for their communities.

ABOUT DIGITAL TWINS

The formal definition of a digital twin, as defined by the consensus-based international standard [ISO/IEC 30173:2023](#) (see the sidebar on p. 2), is

a digital representation of a target entity with data connections that enable convergence between the physical and digital states at an appropriate rate of synchronization. This means that a digital twin is a virtual counterpart to a physical entity, facilitating real-time or appropriately timed data synchronization between them. (Sec. 3.1)

In other words, a digital twin is a digital replica of a real-world place, system, or asset that can be frequently updated with data. A digital twin can have various capabilities, including connection, integration, analysis, simulation, visualization, optimization, and collaboration, discussed further below. It allows planners to monitor, analyze, and test changes to projects, plans, and programs, helping to improve decision-making and optimize planning outcomes.

Digital Twin Components

A digital twin has three core components:

- **Data assets.** Data is needed to “feed” a digital twin and is the centerpiece component of an effective twin.
- **Technology capability.** Various technologies are needed to support the processes of analyzing, simulating, and visualizing data.
- **Human capability.** People determine how a digital twin can help solve a challenge, when it can help, what technology should be used, and which data is needed.

Building an effective digital twin requires balancing these three components as appropriate to organizational goals and corresponding use cases. For example, a planning department may have the latest technology to support data analysis and simulation, but if staff do not have the skills to use that technology, have not clearly defined the problem, or have not integrated the data correctly, the digital twin may not be effective.

Determining use cases is critical to understanding what datasets, technology, and human skills are needed. A digital twin scoping exercise and strategic plan will help an organization determine the level of each component required. These are further discussed later in this article.

Digital Twin Capabilities

Digital twins offer a wide range of capabilities that can help planners perform planning tasks and address challenges. These capabilities can be applied to land use planning, transportation and mobility planning, environmental and sustainability planning, community engagement, policy development, and urban design and placemaking, among others.

Understanding the core capabilities of a digital twin can help planners determine how it can best support their work. Digital twin core capabilities are as follows:

- **Connection.** A digital twin maintains a “live” connection between the digital replica and the physical world/asset/program, bringing data from the physical world into a unified virtual environment.
- **Integration.** Digital twins facilitate the checking and linking of relevant data from different sources to enable meaningful analysis.
- **Analysis.** Digital twins can ingest, process, and analyze data sets from various sources to generate meaningful insights for decision-makers.
- **Simulation.** A digital twin’s computational tools can be used to analyze and predict the impact of planning decisions.
- **Visualization.** A digital twin can display multisource data to the user in multiple dimensions and make it accessible to users.
- **Optimization.** Through the use of real-time data and simulation, digital twins can help users identify and implement decisions that continually improve performance.

Digital Twin Standards

At the international level, one key standard exists that provides guidance for digital twin planning, development, and implementation for urban planning applications.

[ISO/IEC 30173:2023](#) defines the fundamental concepts, terminology, and principles of digital twins, ensuring a standardized understanding across industries. It establishes a framework for digital twin development, emphasizing data connections, synchronization, and lifecycle integration between physical and digital entities.

While not specific to urban planning digital twins, this standard helps create a consistent and scalable approach to digital twin adoption, supporting cross-industry collaboration and technological advancement. It offers a standard definition, core capabilities, description of benefits, and overview of the various stakeholders critical to digital twin strategy and implementation. Such information is valuable to planners as they navigate the process of building support for their digital twins and seek to demonstrate the benefits of digital twins to decision-makers.

ISO 30173 helps cities frame digital twins not just as a technology investment but as a strategic enabler for broader urban goals, such as resilience, sustainability, housing delivery, or mobility improvements. The standard outlines a lifecycle approach to digital twin development, emphasizing scoping, integration, governance, and value realization—critical elements in any business case. By referencing ISO 30173, planners can demonstrate alignment with international good practice, reduce uncertainty about system design and governance, and provide funders and executives with confidence that the city’s digital twin journey is not a one-off technology experiment, but part of a structured, standards-based digital transformation strategy.

Beyond supporting strategy and investment planning, technical standards like ISO 30173 are valuable in helping planners translate vision into action when procuring digital twin technologies. Standards can serve as a common reference point for specifying both functional (what the digital twin should do) and nonfunctional (how it should perform) requirements in procurement documents. This helps vendors understand the expectations around issues such as interoperability, scalability, data integration, and system governance and enables planners to assess digital twin platform options against consistent benchmarks.

By aligning procurement criteria with standardized capability frameworks, planners can better ensure that the technologies procured are fit-for-purpose and focused on the necessary use cases, rather than being sold a generic platform with unsuitable functionality. And by grounding their strategy in a standard such as ISO 30173, planners can avoid ambiguity, ensure consistency in stakeholder engagement, and present a more compelling and risk-aware proposal for funding.

- **Collaboration.** Digital twins can support enhanced collaboration through the sharing of data, allowing stakeholders to co-visualize, test options, and make shared decisions.

When all capabilities are integrated, the digital twin's ability to help decision-makers can be very powerful. These capabilities offer planners a powerful tool to better understand, test, and shape the built environment, supporting their work across a wide range of different planning areas and topics.

- **Land use and zoning.** Digital twins support the modeling of future developments, helping planners evaluate density impacts and promote balanced, sustainable growth in accordance with regulatory provisions and established targets.
- **Transportation and mobility.** Planners can use digital twins to simulate traffic flows, optimize public transit routes, and assess the impact of proposed infrastructure investments before they are implemented.
- **Climate resilience.** Planners can use digital twins to analyze urban heat islands, flood risks, and energy use patterns to ensure development projects are designed to adapt to anticipated climatic disruptions.
- **Infrastructure management.** Digital twins can offer real-time insights into the condition of roads, utilities, and buildings, enabling more efficient maintenance processes and proactive risk mitigation.
- **Community engagement.** Digital twins are often used to augment public participation processes by visualizing proposed plans and alternative schemes, enabling residents to see and respond to potential outcomes early in the planning process. Different planning scenarios can be tested in a robust way using digital twin capability, helping planners assess the potential effects of policies or developments, refine proposals, and communicate key insights to decision-makers.

Digital twins present a wide range of opportunities for use by planners and their local government colleagues. For example, a planner might use a digital twin to speed up their workflow and thus the time taken to process a multiblock redevelopment application for the downtown district by generating and assessing multiple development scenarios. A facilities manager might use real-time Internet of Things (IoT) data, such as occupant movement and room temperature, to analyze space use within a building, allowing them to optimize refurbishment designs. The public works department might use a digital twin to manage infrastructure improvements planning, using data sets that include project scheduling, traffic modeling, neighborhood planning, and social media data to run “what if” simulations to assess community impact. An economic development agency might use a digital twin to help local businesses visualize tourism activity, presenting a multidimensional spatial model of spending data, origin and destination points, and the most popular public places based on social media data. The sidebar on p. 4 describes how Sin-

gapore is using a digital twin of its entire city-state to address challenges and advance outcomes in planning, environmental issues, economic development, and public engagement.

Digital Twin Benefits

The beneficial outcomes of using digital twins in planning workflows include the following:

- **Data-driven planning and decision-making.** Digital twins replace static reports and manual analysis with data updates and predictive analytics to enable evidence-based planning and decision-making. Planners can simulate urban growth, test zoning changes, and assess infrastructure capacity before implementation, reducing potentially costly mistakes.
- **Faster approvals and compliance checks.** Digital twins can automate zoning approvals, building permit review, and regulatory compliance checks, streamlining the development review process and allowing faster review of building permits and development applications.
- **Optimized project planning and design.** Developers and architects can test designs within a digital urban environment, ensuring projects align with zoning and sustainability standards. Businesses and investors can analyze foot traffic patterns, site feasibility, and logistical efficiencies, leading to smarter commercial decisions.
- **Improved stakeholder collaboration.** The shared data environment provided by digital twins can enhance coordination between agencies, property owners, and the public. A more collaborative planning ecosystem benefits all stakeholders involved in urban development.
- **Better public engagement and transparency.** The multidimensional visualizations produced in digital twins can help community members understand planning proposals, improving feedback and trust. Interactive 3D models enable residents to visualize proposed changes, from new housing projects to transport upgrades, making planning more accessible. Environmental monitoring data can also help communities stay informed about air quality, noise pollution, and flood risks. By integrating public input into projects and potential scenarios, digital twin programs can ensure that urban planning decisions reflect community needs, leading to more inclusive and people-centered cities.
- **Efficient infrastructure management.** Monitoring urban assets in real time optimizes maintenance activities, reduces costs, and prevents failures.
- **More nimble and adaptive planning.** The dynamic modeling offered by digital twins helps planners identify and respond to more complex challenges more quickly.

As evidenced by this list, digital twins offer a wide range of potential benefits to planners.

CHALLENGES TO DIGITAL TWIN ADOPTION

Though digital twin technology is emerging as a powerful tool for improving decision-making in cities, infrastructure,

and industries worldwide, its adoption remains slow due to high costs, technical complexity, and the need for better data integration. Globally and in the United States, digital twin adoption is fragmented, with some cities, industries, and government agencies leading the way while others lag. Similarly, different sectors—such as transportation, utilities, and real estate—are advancing at different paces, limiting the full potential of digital twins.

Key barriers to digital twin adoption include the following:

- **Lack of awareness.** Many decision-makers, planners, and stakeholders are still unfamiliar with the concept of digital twins. Without a clear understanding of their value and capabilities, they will hesitate to invest time and resources into their adoption. Accessing APA's online digital twin training and development resources in [Passport](#) is a good

starting point for building fundamental knowledge about the “what, why, and how” of digital twins. Supplementing this with international resources such as the [UK Digital Twin Hub](#) and the [Digital Built Australia Podcast](#), planners can choose which level of knowledge matches their capability development needs.

- **No single software package.** Unlike traditional planning software, digital twins are not a single, out-of-the-box solution. They require integrating multiple technologies, platforms, and data sources, making implementation sometimes complex and highly customized. Planners should focus on the use cases most relevant to their communities to help guide them in engaging with vendors and identifying the most suitable software solutions.
- **Resource constraints.** Digital twins may require significant investment in hardware, software, and data infra-

Virtual Singapore: Pioneering a Nation-Scale Digital Twin

[Virtual Singapore](#) is a dynamic 3D digital twin of the entire city-state, developed to enhance urban planning, resource management, and policymaking. Launched in December 2014, this SGD 73 million initiative is a collaboration among the National Research Foundation, Singapore Land Authority, and the Government Technology Agency, using Dassault Systèmes' 3DEXPERIENCE City platform.

Singapore faced several urban challenges that necessitated the development of Virtual Singapore:

- **Land scarcity.** As one of the world's most densely populated countries, Singapore needed innovative solutions to optimize land use without physical trial and error.
- **Complex urban infrastructure.** Managing aboveground and underground utilities required a comprehensive understanding of spatial relationships and potential conflicts.
- **Climate change and sustainability.** The city-state needed tools to model environmental impacts, such as flood risks and urban heat islands, to inform sustainable development.
- **Interagency coordination.** Multiple government agencies required a unified platform to share data and collaborate on urban planning initiatives.

Virtual Singapore addresses these challenges through a multifaceted approach:

- **High-resolution 3D modeling.** Using aerial lidar, vehicle-mounted laser scans, and extensive imagery, the platform creates detailed representations of buildings, terrain, and infrastructure.
- **Integration of diverse data sources.** The platform consolidates data from agencies such as [OneMap](#) as well as real-time sensor data from the [Smart Nation](#) initiative.
- **Context to data.** Beyond visual representation, the model

includes information about building usage, materials, and energy consumption, enabling complex simulations.

- **Collaborative platform.** Virtual Singapore serves as a shared environment for government agencies, businesses, researchers, and eventually the public, fostering collaboration and innovation.

The implementation of Virtual Singapore has led to significant advancements:

- **Enhanced urban planning.** Planners can simulate various scenarios, such as new infrastructure projects or disaster response plans, to assess potential impacts before implementation.
- **Improved infrastructure management.** The platform aids in coordinating underground utility works, reducing the risk of service disruptions and improving safety.
- **Environmental monitoring.** Real-time data integration allows for monitoring of environmental factors, supporting initiatives like green building development and flood risk assessment.
- **Economic opportunities.** Businesses can leverage the platform for analytics, resource planning, and developing specialized services, contributing to economic growth.
- **Public engagement.** By providing access to certain data layers, citizens can participate in urban development discussions, promoting transparency and community involvement.

Virtual Singapore offers a glimpse into the potential of digital twins in urban governance, offering a blueprint for other nations and cities seeking to harness technology for sustainable and efficient city planning and management.

structure, which local governments often struggle to fund. Limited budgets make large-scale implementation difficult. One way to overcome this barrier is to begin with use cases that can be implemented using existing resources. Planners can also break down the various tasks in digital twin planning and focus on generally applicable technology investments, such as reviewing data availability, quality, and capability to manage data from a safety, security, governance, and ethics perspective.

- **Training needs.** Many organizations lack staff trained to use and manage digital twin tools effectively, potentially requiring additional investment in workforce training. Planners may need to seek out training and guidance on technology-intensive planning tools, such as advanced data analytics, artificial intelligence (AI), and simulation modeling, to fully leverage digital twins.
- **Lack of unified standards.** While common standards exist for digital twin data integration, interoperability, and governance, their adoption is not common, making it challenging to scale digital twins across different sectors, cities, and regions. And as noted above, existing digital twin standards are not specific to urban planning. Engaging with peers and standards experts can help planners establish a framework for action that aligns with best practices, particularly when relevant standards are lacking.
- **Siloed efforts.** Many digital twin initiatives are developed in isolation by individual organizations or departments, limiting collaboration, data sharing, and the ability to create interconnected, citywide, or national-scale systems. Early engagement to build co-ownership in the value creation from digital twin investments is an important strategy to avoid siloed and potentially duplicative efforts. Planners should adopt shared standards (like ISO 37173), work across departments and agencies to share responsibilities, and design digital twin initiatives with interoperability and open data principles from the outset. This ensures alignment with broader city or national digital infrastructure goals.

For planners seeking to implement digital twin technology within their agency or organization, the path can be challenging. Fragmented data, limited internal capability, competing priorities, and uncertainty around return on investment can slow progress or impact efforts entirely. Without a clear sense of direction, even well-intentioned initiatives risk becoming disconnected actions that fail to deliver lasting value. A methodical, thoughtful approach is essential to align digital twin ambitions with broader planning and organizational goals and build internal support and capability over time.

Creating a strategic framework for digital twin development provides the foundation needed to move from concept to action. It allows planners to define their objectives, assess readiness, identify requirements, and establish partnerships. A structured roadmap helps ensure each step is purposeful and achievable. Rather than trying to “do everything at once,” this approach focuses on sequencing effort, learning iteratively, and preparing for solutions that deliver real outcomes.

DEVELOPING A DIGITAL TWIN STRATEGIC FRAMEWORK

Developing and implementing a digital twin framework necessitates a structured and strategic approach to ensure its successful integration into planning practice. Planners can follow a three-step process to develop a digital twin framework.

1. **Develop a scoping paper.** Clearly define the scope of digital twin implementation, focusing on planning objectives, challenges, and desired outcomes. This document is typically used to garner early support for the development of a full digital twin strategy.
2. **Create a comprehensive strategy.** Develop a strategy that supports the scalability and efficiency of digital twins by integrating people, processes, information, and technology. This document builds on the scoping paper, offering more detailed information to support a business case and guide action and investment.
3. **Build a business case.** Outline the costs, benefits, and value of delivering digital twin use cases across the organization. Depending on the existing business case procedures an organization may have in place, this may be a high-level overview or a more detailed financial assessment. Ultimately, this document supports decision-making for funding a digital twin program.

Establishing a vision and goals for the digital twin, laying out an implementation plan, and making the case for investing in this valuable planning tool are key elements in successfully adopting digital twin technology.

Step 1: Develop a Scoping Paper

The purpose of a scoping paper is to provide a clear position for initiating a digital twin program. It outlines the program's objectives, defines its scope, and identifies critical elements such as data requirements, technology integration, resource allocation, and success metrics. A well-constructed scoping paper serves as a foundational tool to align stakeholders, set expectations, and guide the program through future phases.

Carefully considering each of the key scoping paper components shown in Table 1 (p. 6) and discussed below ensures alignment among stakeholders and creates a structured approach for future stages. Typical stakeholders involved in planning-related digital twins include planning and GIS teams, information technology (IT) departments, asset managers, transportation and infrastructure agencies, environmental services, and executive leadership. Stakeholder collaboration is essential in developing the scoping paper to ensure the program reflects real-world needs and addresses relevant challenges, aligns with organizational priorities, and leverages cross-departmental knowledge.

Objective

Clearly define the purpose and objectives of your digital twin program. What issues do you aim to address, and what goals

Table 1. Digital Twin Scoping Paper Components

Component	Description
Objective	Program goals aligned with organizational priorities
Scope	Top-down or bottom-up approach; clearly defined use cases
Data requirements	Datasets and sources for defined use cases
Integration with existing systems	Review of existing system requirements
Resource assessment	Assessment of staff time, technical capacity, technology needs, and budget availability
Security and privacy considerations	Data protections
Timelines and milestones	Phased project schedule with major milestones and actions
Measurement of success	Benchmarking and performance metrics

do you hope to achieve? How do these align with community and organizational priorities? A precise objective provides direction to all subsequent planning.

As an example, the following program goal seeks to address some common urban issues such as resilience, sustainability, and cross-agency coordination of services:

To create a data-integrated digital representation of the city that supports evidence-based decision-making for infrastructure planning, improves service delivery, and enhances community engagement through scenario modeling and transparent data access.

Scope

Determine the scope of your digital twin program. Decide whether to adopt a top-down approach (high-level goals driving detailed steps) or a bottom-up approach (starting with specific processes or systems and scaling upward).

A top-down approach ensures alignment with strategic city goals and fosters cross-agency integration, but it can be slower to implement and may struggle to account for on-the-ground complexities. A bottom-up approach enables quick wins, can foster greater stakeholder support, and facilitates practical experimentation. However, it risks siloed development and may lack a cohesive city-wide vision.

Regardless of approach, it is important to clearly define program boundaries to avoid scope creep. This is best done by identifying clear use cases, implementing a phased roadmap, and establishing governance with a formal change control process to assess new requests. A common approach is to determine the minimum level of technology investment necessary to demonstrate value. This helps reduce the risk of overinvesting in technology that does not serve your needs.

Data Requirements

Identify the types of data that will be inputs for your digital twin. Common digital twin data sources include the following:

- **Geographic information systems (GIS).** Digital twins rely on a foundation of spatial data and GIS to map land use, infrastructure, and environmental features.
- **Historical datasets.** Existing data on past and current conditions can provide baseline trends and context for simulation and prediction.
- **Internet of Things (IoT).** Real-time data from IoT sensors, such as traffic flow, air quality, and energy usage, enables dynamic monitoring and analysis.
- **Existing models.** Existing asset models can be integrated to enhance the digital twin's functionality. This can support modeling activities associated with core challenges such as transportation and stormwater management, among others.

Data sets such as traffic flows, proposed new developments, existing drainage infrastructure, and urban tree canopy are just some examples. Ensuring this data is accurate, up-to-date, and aligned with the program's use cases is essential for meaningful insights and decision-making.

Integration With Existing Systems

Assess how the digital twin will integrate with your organization's current infrastructure and tools. Ensure interoperability with systems such as asset management software, planning databases, or other analytics platforms to maximize the digital twin's value.

For context, a digital twin can integrate with existing infrastructure by connecting to asset management systems, such as Cityworks or IBM Maximo, to visualize maintenance schedules and asset performance in real time. It can also link with planning databases and GIS platforms such as Esri ArcGIS to map zoning, permitting, and land use data.

To ensure interoperability, local governments should adopt open data standards (like [CityGML](#) or [IFC](#)) and use application programming interfaces (APIs) to enable seamless data sharing across systems and maximize functionality. When evaluating systems integration requirements, planners should reach out to IT and other stakeholders in their organizations or local

governments to ensure the digital twin program becomes an initiative with wide user support.

Technology Evaluation

Review the capabilities of digital twin technologies and platforms to identify the best fit for your program’s needs. Consider scalability, adaptability, and ease of implementation during this evaluation.

As digital twins are still an emerging technology and the field is rapidly evolving, the best ways to gather this information in the early stages of a scoping process are through internet searches and reaching out to digital twin platform providers to learn more about what each system offers. Engaging a consultant with expertise and access to relevant tools, networks, and reference materials can help streamline this task.

Resource Assessment

Evaluate the resources, both human and financial, required to launch and sustain the digital twin program. Include considerations for staffing, training, software licenses, hardware, and ongoing maintenance.

Assess your resource needs by mapping the digital twin program’s initial scope to generic staffing requirements, including roles for project management, data management, system integration, and ongoing operational support, while also accounting for necessary training to build internal capability. Financial estimates should include both initial and recurring costs for software licenses, cloud or on-premise infrastructure, hardware (e.g., sensors or servers), and long-term maintenance. These estimates can be calculated by benchmarking against similar projects undertaken by the organization, consulting with vendors for indicative pricing, and engaging finance teams to scope a total cost of ownership model over the program’s lifecycle. A consultant could also assist with the resource assessment.

Security and Privacy Considerations

Address the security and privacy implications of your digital

twin program. Adopt strategies to protect sensitive data and comply with relevant regulations, ensuring the confidence of stakeholders and the community. Planners must ensure digital twin projects comply with relevant U.S. data privacy and security regulations, such as the Federal Information Security Management Act (FISMA), state-level privacy laws (e.g., CCPA in California), and sector-specific standards.

Strategies could include applying data minimization principles, enforcing role-based access controls, and implementing encryption to safeguard sensitive or personally identifiable information. Adopting recognized cybersecurity frameworks such as [NIST SP 800-53](#) or the [NIST Cybersecurity Framework](#) helps establish a structured, risk-based approach to securing systems and data. Collaborate with IT departments, legal counsel, and risk officers to conduct regular security assessments and maintain compliance with institutional and regulatory obligations.

Timelines and Milestones

Establish a realistic timeline for implementation, including key phases such as data integration, pilot testing, and full deployment. Define milestones to track progress and keep the project on schedule. Table 2 presents a generic program timeline.

Measurement of Success

Define clear metrics to measure the program’s success. These could include improved decision-making efficiency, cost savings, enhanced stakeholder engagement, or measurable outcomes in operational performance.

To measure success, you will need to track key performance indicators (KPIs) over time for the program. This involves establishing a baseline before implementation, then using analytics tools to monitor progress, system usage, response times, and stakeholder satisfaction. Regular reviews, case studies, and feedback loops with internal and external users help demonstrate value, inform relevant adjustments, and support ongoing investment requests.

Table 2. Basic Digital Twin Planning and Implementation Timeline

Time	Task	Actions
0–3 months	Planning and scoping	Define goals, engage stakeholders, assess resources, and establish governance
3–6 months	Data audit and integration preparation	Inventory existing datasets, evaluate quality, and design a data management framework
6–9 months	Technology procurement and setup	Conduct vendor engagement, select platform, and configure core infrastructure
9–12 months	Proof of concept/pilot testing	Integrate initial datasets, run early use cases, and gather feedback for refinement
12–18 months	Full deployment and capability building	Scale integration across departments, embed tools in workflows, and train staff
18+ months	Optimization and improvement	Monitor outcomes, enhance features, and expand use cases based on feedback

Table 3. Digital Twin Strategy Steps

Step	Description
Confirm objectives	Confirm key goals identified in scoping paper
Engage stakeholders	Based on use cases, identify and engage internal and external stakeholders
Assess current capabilities	Evaluate current digital platforms and data landscape against digital twin needs
Identify data and technology needs	Based on use cases, identify needed datasets and suitable technology platforms
Set priorities	List program elements and prioritize by importance; look for easy wins
Create an implementation roadmap	Develop a phased timeline outlining milestones, timeframes, responsibilities, and dependencies
Finetune performance tracking metrics	Refine benchmarking and tracking metrics identified in scoping paper

Step 2: Create a Digital Twin Strategy

Creating a digital twin strategy is the next foundational step that ensures the program aligns with organizational objectives, engages key stakeholders, and provides a clear path forward.

The digital twin strategy builds on the work undertaken as part of the scoping paper preparation, adding more details that support implementation. The strategy also forms an important foundation for the digital twin business case.

A comprehensive digital twin strategy allows planners to build a strong foundation for program development and implementation. By following the structured steps summarized in Table 3 and discussed below, planners can ensure alignment with stakeholder needs, address technical and organizational challenges, leverage emerging opportunities, and monitor progress through measurable outcomes.

Confirm Objectives

Building on the objectives identified in your digital twin scoping paper, confirm the key goals your digital twin program will achieve, such as improving operational efficiency, enhancing predictive capabilities, or supporting smarter decision-making.

Engage Stakeholders

It is important to identify and engage relevant stakeholders early in the development of a digital twin strategy. Begin by mapping the anticipated use cases, such as infrastructure planning, transportation modeling, or climate resilience, and then identify the departments and partners most affected or required to deliver those outcomes.

This process should include conversations with internal teams, such as permitting, GIS, asset management, and IT, as well as municipal leadership who will champion or fund the initiative. You should also engage external stakeholders, including utilities (e.g., water and energy providers), state or federal government agencies (e.g., departments of transportation or environment), and private-sector technology vendors who may supply data or digital platforms. For use cases that will involve community and business stakeholders, such as a digital twin visualization process that facilitates public feedback,

engagement with residents and business owners may also provide valuable input.

Assess Current Capabilities

Drawing on the resource assessment from the scoping paper, conduct a thorough review of your organization's current digital and data landscape to evaluate its readiness for a digital twin program. This process typically involves mapping existing systems, such as GIS platforms, asset management tools, e-planning systems, and planning databases, while also assessing the quality, accessibility, and interoperability of available datasets. Additionally, evaluate in-house technical expertise, including staff capabilities in data analysis, system integration, and digital project delivery.

The core capabilities of digital twins—data integration, analysis, simulation, and visualization—can provide a framework for this assessment. The objective is to identify capability gaps, such as outdated systems, siloed data, or limited staff capacity, that could impede effective implementation.

After identifying any such limitations, prioritize areas for action and investment. This may include upgrading platforms, hiring specialized staff, or consulting with external advisors to enhance digital twin readiness.

Identify Data and Technology Needs

Drawing on the scope, data requirements, and technology evaluation from the scoping paper, confirm and clearly define the use cases the digital twin will support, whether it be infrastructure management, mobility analytics, or climate adaptation. These use cases will guide what data is needed.

From there, identify and confirm relevant data types and sources, which, as previously discussed, typically include geospatial data (e.g., land use, zoning, 3D city models), IoT sensor feeds (e.g., traffic, air quality, energy consumption), and legacy datasets (e.g., planning approvals or asset maintenance records). Review the accuracy of external data sources and engage with internal data owners early to confirm what is available and identify any data gaps or quality issues that could affect the digital twin program.

Once data needs are defined, focus on evaluating suitable technology platforms. Key criteria include integration capabilities with existing systems (e.g., GIS, asset management, enterprise resource planning), scalability to support citywide deployment, and flexibility to accommodate evolving use cases and new data streams over time. Planners should prioritize platforms that support open standards (such as CityGML or IFC), offer robust APIs, and provide strong user and permissions management. Engaging cross-agency/department stakeholders, IT, and procurement teams in these discussions can help align platform selection with program objectives, internal requirements, and long-term digital strategy.

If possible, conduct a market scan with vendors to gather more information and address any identified risks. As previously highlighted, digital twin technologies must align with the strategic objectives of the digital twin program and broader organizational goals. Look for tools that facilitate better decision-making, promote transparency and community engagement, and enhance operational efficiency across departments. Also consider the total cost of ownership, including not only licensing and implementation costs but also ongoing support, training, and the ability for your data and other systems to function effectively across different technologies.

Set Priorities

To effectively prioritize activities within a digital twin strategy, begin by listing all potential program elements and mapping them against strategic objectives, stakeholder needs, and anticipated value.

Key activities often include data integration, platform selection, governance structures, piloting use cases, and internal capacity building. Assess each activity based on its importance and alignment with high-impact goals, such as climate resilience, infrastructure planning, or operational efficiency, and its feasibility based on resource availability, technical readiness, and stakeholder support. You can use a simple prioritization matrix to identify those that require immediate focus or are best reserved for later phases. Ranking activities in a structured and transparent way allows planners to communicate priorities clearly and deliver a phased, strategic roadmap for implementation.

Focus on identifying early wins: activities that are both easy to implement and highlight the value of the digital twin. An example might be piloting the digital twin for the municipality's stormwater management system, moving existing 3D models into a new visualization hub that ingests and integrates real-time data to track performance, detect issues, and test proposed improvements. These successes can help create both internal and external momentum, which is important for securing long-term investment, gaining stakeholder commitment, and fostering the necessary change to integrate digital twin thinking into planning workflows.

Create an Implementation Roadmap

The implementation roadmap will guide resource planning and stakeholder alignment throughout the digital twin

program's journey. Using the priorities identified earlier in the digital twin strategy development process and drawing on the timeline developed in the scoping paper, establish a high-level implementation timeline segmented into phases, such as foundation-building, pilot implementation, scaling and integration, and optimization. Each phase should be supported by clear actions and deliverables, such as completing a data inventory, launching a proof of concept or integrating planning approvals into the digital twin.

For each phase, the roadmap should outline milestones, timeframes, responsibilities, and any dependencies that must be addressed before moving to the next stage. Critical milestones and hold points should be highlighted, such as securing executive endorsement, completing a data governance framework, or successfully deploying a proof of concept. Define roles and assign responsibilities to relevant teams or individuals to ensure accountability and effective collaboration, clarify expectations, and maintain momentum. A visual timeline or Gantt chart can help communicate the roadmap effectively to decision-makers and partners.

Refine Performance Tracking Metrics

Building on the success metrics drafted in the digital twin scoping paper, you may need to refine your metrics to be more specific to your use cases, ensuring that they directly align with the program's objectives. These should include improvements in decision-making, reductions in relevant cost components, enhanced performance against key urban challenges (e.g., land supply, flooding, traffic congestion), and tangible gains in stakeholder engagement and other social indicators.

To prepare for this performance tracking process, establish a baseline of current conditions across relevant domains, such as asset maintenance, service delivery timelines, or public satisfaction levels, as benchmarks for demonstrating the impact of the digital twin over time. Meaningful and measurable KPIs that use data analytics to assess usage, adoption, and system outputs may include the number of cross-departmental use cases enabled, reductions in unplanned maintenance events, or the percentage of planning decisions supported by the digital twin.

Regular performance reviews should be integrated into the program's governance structure. This should combine quantitative data with qualitative feedback from stakeholders gathered through user surveys, interviews, and case studies. This feedback loop not only validates the value delivered but also highlights new opportunities for improvement.

Step 3: Build a Business Case

The business case is a critical tool that supports the process of securing a mandate and funding for a digital twin program. It consolidates the work undertaken in the scoping paper and strategy and presents research, analysis, and evidence necessary to support a decision to fund the program. It is a living document and should be revised and updated as more detailed information becomes available. At its final stage, the business case becomes the primary document summarizing

the digital twin program's objectives, implementation methodology, and plans for post-implementation evaluation.

The level of effort required to develop a business case should be proportional to the program's potential costs and benefits. Business cases can vary widely in scope, ranging from large-scale city-wide digital twin investments to smaller, targeted pilot initiatives. The scope of a business case will also depend on potential organizational and community influencing factors, such as the following:

- Existing guidelines for business case development
- Specific needs of executive leadership or elected officials
- Existing budgetary and funding priorities
- Contributions from partners, including foundations and the private sector

A comprehensive business case typically addresses five interconnected aspects that are important to funding decision-makers and program champions. Each of these aspects ensures that financial stakeholders and other decision-makers can confidently evaluate the viability and effectiveness of the program. As described in a [short plain-English guide](#) from the UK's HM Treasury Green Book, the five types of information contained in a business case are as follows:

1. **Strategic information.** This explains why the digital twin program is necessary. It outlines the challenges or opportunities that the program addresses, provides context on organizational priorities or external drivers, and ensures alignment with strategic goals. This information builds a case for change and establishes the program's justification and importance.
2. **Economic information.** This should demonstrate that the digital twin program offers optimal value for money. It should compare potential implementation options and evaluate their costs, benefits, and risks. It should highlight preferred solutions and their ability to achieve the best returns on investments, incorporating cost-effectiveness and long-term benefits.
3. **Commercial information.** This presents the commercial viability of the program by addressing procurement and partnership strategies. It includes how the digital twin program will leverage third-party providers, software platforms, or other vendors, ensuring that the approach fosters a viable and sustainable relationship with suppliers and partners.
4. **Financial information.** This confirms the program's financial feasibility, including proposed budget, funding sources, and cash flow forecasts to demonstrate that the program can be supported by the financial resources available. This should establish clarity and confidence in the program's economic management.
5. **Management information.** This describes how the program will be delivered successfully, the governance structures (such as relevant cross-agency management arrangements and steering committees) recommended

to support the program, accountability mechanisms, and project management processes. It should include plans for risk management, stakeholder engagement, and performance monitoring to maintain focus and ensure effective implementation.

The business case for a digital twin program should evolve alongside the program's scoping, strategy development, and stakeholder engagement. As the strategy is developed, the business case should address the five core dimensions—strategic alignment, economic value, commercial viability, financial affordability, and implementation feasibility—to demonstrate how the digital twin will support planning priorities, improve service delivery, and offer a sound return on investment.

A well-structured business case is not just a tool for internal decision-making; it also builds transparency and trust with executives, finance teams, and elected officials by clearly articulating the rationale and expected outcomes of the program. Planners should revisit and refine the business case regularly to reflect updated cost estimates, new use cases, stakeholder input, and changing municipal priorities.

ACTION STEPS FOR PLANNERS

Creating a digital twin program for an organization can be both exciting and complex. It involves following clear steps to ensure success. This *Memo* provides a systematic and comprehensive approach to the process. Whether you're just starting out or are further along on your digital twin journey, the following steps can help advance your efforts.

For those who are unsure if a digital twin is for them: start with research. You and your colleagues may not be thoroughly convinced as to whether and how a digital twin can support your project or organization. This is common. Here are some practical suggestions to help you work through determining if digital twins may offer value to your planning efforts:

- Identify peer organizations that are investing in digital twins and engage with them to understand their goals and actions, why they pursued digital twin capability, and what value it has created.
- Learn by reading articles, watching videos, and researching case studies, and meet with stakeholders (such as cross-agency/department colleagues who can benefit from the digital twin) to discuss views and identify potential opportunities for using a digital twin.
- Engage with external consultants with experience in digital twin projects to explore opportunities with digital twins in urban planning.

The sidebar on p. 11 offers additional digital twin resources to start your learning journey.

For those just starting out: develop a scoping memo. If you're at the beginning of your digital twin initiative, focus on

Digital Twin Resources

The following list of resources offers some good places to start learning more about digital twin technology.

["Smart City Digital Twins"](#) (*PAS QuickNotes* 89, by John Taylor and Neda Mohammadi). This *PAS QuickNotes* defines smart city digital twins and explores how this emerging tool can be used to support better decision-making, more effective stakeholder engagement, and more robust scenario planning processes.

["Smart City Digital Twins Are a New Tool for Scenario Planning"](#) (*Planning*, April 1, 2021, by Petra Hurtado and Alexandra Gomez). This article overviews the potential benefits of smart city digital twins for scenario planning, allowing planners to explore new solutions to urban problems, improve planning activities such as public engagement and zoning, and address complex issues like climate resilience.

[Digital Twins and Planning](#) (APA Research KnowledgeBase). This curated collection of resources offers reports, articles, trainings, and examples of urban digital twins from around the world.

["Understanding Current Assets and Future Needs with Digital Twins"](#) (*Esri ArcUser Manager's Corner*, 2023, by Keith

Cooke). This article describes how State College, Pennsylvania; Talent, Oregon; and Colton, California, are using digital twins to address planning challenges.

["The Adoption of Urban Digital Twins"](#) (*Cities* 131(2022): 103905, by Jaume Ferré-Bigorra, Miquel Casals, and Marta Gangoells). This research paper examines the characteristics of existing urban digital twins, including use cases, data inputs and outputs, and challenges.

[Digital Twin Hub](#) (Connected Places Catapult). This UK-based knowledge-sharing platform offers practical guidance, case studies, and maturity frameworks for digital twin development across city systems.

[The Gemini Papers](#) (Centre for Digital Built Britain, 2022). These summary reports from a British think tank address the "what, why, and how" for an ecosystem of connected digital twins.

[Digital Twin Capabilities Periodic Table](#) (Digital Twin Consortium, 2023). This comprehensive list of digital twin capabilities is grouped into categories (data services, integration, intelligence, user experience, management, and trustworthiness) and displayed in a periodic table format.

creating a scoping memo. In contrast to the comprehensive scoping paper described in the guidance above, a scoping memo lays out your early thinking on a digital twin program and its benefits. Consider the following in preparing your memo:

- **Define objectives and outcomes.** Identify your big-picture aims for a digital twin program. Do you want to enhance operational efficiency? Improve decision-making? Reduce costs?
- **Review existing assets and systems.** Evaluate your current infrastructure, data availability, and system capabilities to understand what you can leverage for the digital twin.
- **Assess stakeholder needs.** Engage with key stakeholders (such as cross-agency/department staff likely to benefit from the digital twin) to define their interests and any specific requirements.
- **Identify scope.** Consider the scale of your initial efforts. Will the digital twin be used for a single operational process, a specific asset, or a broader system or project?

You can use the scoping memo to inform key stakeholders and decision-makers of the potential opportunities for creating value from investing in digital twin capability.

For those who are more advanced: consider a proof of concept. While you work on your digital twin strategy and build out your business case, consider initiating a proof of concept to demonstrate the value of digital twin technology and generate early momentum.

In the context of digital twins, a proof of concept is a small-scale, practical demonstration of how the technology could work in a specific planning or operational context. It allows planners and decision-makers to test ideas, validate assumptions, and explore how digital twin capabilities can integrate with existing systems and processes—all before committing to a full-scale rollout. This helps uncover potential issues early and reduces risk as the program moves forward. A proof of concept can be undertaken at any time during your digital twin journey.

This may be most feasible for organizations with existing capability in GIS or data management and analytics, or it may involve inviting technology vendors to submit proposals so you can compare capabilities and pricing of different systems. In some cases, vendors may allow you to "test drive" a system for a limited time with a defined use case.

Consider the following as achievable proof-of-concept goals:

- **Demonstrating value quickly.** Focus on a specific use case that addresses a tangible problem or creates measurable benefits quickly. This will help garner support for scaling your actions and building further digital twin capability.
- **Leveraging existing resources.** Use readily available data and technologies, such as organizational capability in GIS or data management and analytics, to minimize upfront costs and complexity.
- **Building program support.** Work with other stakeholders in your department or organization to strengthen your efforts and create program buy-in.

- **Testing assumptions.** Use the proof of concept as an opportunity to validate assumptions relating to common planning challenges or emerging project opportunities.

By running the proof of concept alongside your strategic planning process, you can demonstrate immediate value, build confidence in digital twins, and create a better-informed foundation for future scaling efforts. The insights you gain can help to refine program objectives, clarify investment needs, and shape a more robust and actionable digital twin strategy.

CONCLUSION

Digital twin technology has the potential to serve the planning community in new ways. Not only can this tool transform the way we visualize and analyze urban environments, it can also foster collaboration and innovative solutions by using data in new ways to unlock valuable insights.

Though the path to adopting this emerging technology may seem daunting, a strategic approach can help planners enhance their understanding of digital twins and build a case for investing in this valuable tool. As you consider integrating digital twins into your planning processes, focus on building interdisciplinary partnerships that leverage diverse expertise and perspectives. Prioritize adaptability and scalability in your strategy, ensuring that the digital twin can evolve alongside the dynamic nature of planning and the challenges faced by planners. Engage with stakeholders early to foster trust and collaboration, ensuring that the digital twin serves the needs of all users. And at any stage of the process, use this *Memo* to guide your journey to investing in the transformative technology of digital twins.

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