AI and Hybrid Intelligence in Infrastructure Management: Transforming the Future of Public Infrastructure

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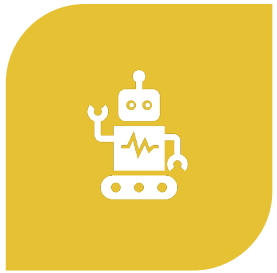
OCTOBER 29, 2025

Defining AI and Hybrid Intelligence

Hybrid Intelligence Operating Model:

- Human defines goals, ethics, oversight
- AI perceives and predicts
- Co-learning feedback improves both



AI: MACHINE-BASED SYSTEMS THAT PERFORM PERCEPTION, PREDICTION, AND DECISION OPTIMIZATION.

HI: INTEGRATION OF HUMAN JUDGMENT AND AI ANALYTICS FOR CONTEXTUAL, ETHICAL, AND ADAPTIVE DECISION-MAKING.

What is Artificial Intelligence in Infrastructure?

Definition:

Artificial Intelligence (AI) in infrastructure management refers to computational systems that can perceive environmental data, learn from patterns, make decisions, and take actions to optimize infrastructure operations, maintenance, and planning with minimal human intervention.

Key Capabilities:

- Pattern recognition
- Predictive analytics
- Automated decision-making
- Real-time optimization

Applications Include:

- Traffic flow optimization
- Predictive maintenance
- Resource allocation
- Infrastructure monitoring

Hybrid Intelligence: The Human-AI Partnership

Definition:

Hybrid Intelligence combines human cognitive abilities (creativity, ethical judgment, contextual understanding) with AI computational power (data processing, pattern recognition, continuous monitoring) to create decision-making systems that outperform either humans or AI working independently.

Role in Infrastructure Management:

👤

Human Provides

Strategic vision, ethical oversight, stakeholder engagement

🤝

Together Create

Optimal infrastructure decisions and outcomes

🤖

AI Provides

Data analysis, predictions, 24/7 monitoring

Challenges and Opportunities

- AI increases effectiveness and efficiency and potentially reduces costs for organizations and communities.
- AI advancements are accelerating.
- Increased accessibility – service enhancement and improvements (in energy, water, sewer, emergency response, disaster preparedness, traffic management).

- Ethical and governance concerns.

AI in Public Safety & Smart Cities

Seoul, South Korea — AI in 119 emergency services: AI streamlines Seoul's emergency report systems in the event of large-scale disasters such as heavy rainfall, earthquakes, or wildfires, Seoul's municipal government said Wednesday. Seoul's 119 emergency system, applied during call surges, is South Korea's first AI-based emergency service. "AI callbot" categorizes the incident as an emergency or requiring immediate response and connects the caller to the Seoul Comprehensive Disaster Prevention Center's receptionist for priority handling.

Stockholm, Sweden — Air quality + traffic management Stockholm uses a combination of AI, predictive modeling, and advanced sensors to improve traffic management and air quality.

Copenhagen (Denmark) – Intelligent Flood Prevention

•Uses AI and hydrological modelling to predict stormwater surges and manage urban drainage.

•Combines sensor networks, rainfall radar, and a city-scale digital twin for early warnings.

- Source: *Copenhagen Solutions Lab – Smart Water Management* — solutionslab.kk.dk

AI in Public Safety & Smart Cities (Contd.)

Toronto deploys AI to optimize city functions and improve resident experiences. Examples include:

- **Traffic management:** AI-powered traffic lights and signal timing are being used to reduce congestion and improve public transit reliability.
- **Financial management:** The city is using predictive analytics for budgeting and fraud detection to improve efficiency and financial transparency.
- **Customer service:** AI-powered chatbots assist residents with city services.

Across **Los Angeles** and California, artificial intelligence (AI) is being used to enhance wildfire risk assessment and response.

Predictive risk modeling: Companies like ZestyAI use AI to analyze decades of wildfire data, combining it with satellite and aerial imagery, topography, and property characteristics to provide precise risk assessments.

Preventive monitoring for utilities: A study by AiDASH on the 2025 Los Angeles wildfires revealed that AI analysis of satellite data could have detected key risk factors, such as vegetation dryness and temperatures, weeks in advance

AI in Transportation Infrastructure (Contd.)

Netherlands — Predictive road maintenance (national)
A modern AI, IoT and analytics platform powered by SAS® Viya® 4 helps Rijkswaterstaat move from reactive to predictive infrastructure maintenance.

+ Rotterdam (Netherlands) – Port Digital Twin
•The Port of Rotterdam deploys a full AI-powered digital twin that integrates IoT sensors and vessel traffic data.
•Improves cargo logistics, safety, and emissions management through predictive analytics.
•Provides a reference model for other global maritime AI applications.
Source: *Port of Rotterdam Authority – Digital Twin Initiative* — portofrotterdam.com*IBM & Port of Rotterdam Collaboration Overview* — ibm.com
Rijkswaterstaat (Ministry of Infrastructure): https://www.rijkswaterstaat.nl/english

Singapore – Smart Traffic Management
•AI integrates real-time camera, sensor, and GPS data to dynamically control intersections.
•Forms part of Singapore's "Smart Nation" urban mobility system.

- Source: *Smart Nation Singapore – Mobility* — smartnation.gov.sg
- *Intellistride Blog – Smart Traffic System* — https://www.lta.gov.sg/content/ltagov/en/getting_around/driving_in_singapore/intelligent_transport_systems.html

AI in Transportation Infrastructure (Contd.)

Japan — Railway predictive maintenance (Shinkansen & JR)

•East Japan Railway Company (JR East): https://www.jreast.co.jp/e/
•Central Japan Railway Company (JR Central): https://global.jr-central.co.jp/en/
•International Union of Railways (UIC) technical briefs: https://uic.org/

Japan's railway predictive maintenance for Shinkansen and JR systems relies on advanced technologies, including AI-powered sensors and cameras, to monitor components such as overhead wires, rails, and train parts in real time. This condition-based maintenance (CBM) strategy shifts from fixed-schedule inspections to predictive maintenance that addresses potential failures before they occur, improving safety, efficiency, and reliability.

AI in Transportation Infrastructure (Contd.)

London, UK — AI-enabled bridge/asset monitoring
AI assists the UK authorities in shifting from reactive to predictive maintenance for aging infrastructure, such as bridges, which are vital to London's transport network.

- **Early issue detection:** Machine learning algorithms analyze sensor data from bridges to detect subtle changes that indicate structural problems before they are visible to human inspectors.
- **Use of digital twins:** Engineers are creating "digital twins" of bridges—virtual models that are continuously updated with real-world sensor data.
- **Automated visual inspections:** Datagrid announced that its AI agents use computer vision and drones to automatically detect cracks and deterioration in bridge decks, improving accuracy and reducing risks for human inspectors.

Infrastructure management: National Highways, which manages the orbital M25 motorway around London, uses advanced asset management software with AI to oversee thousands of structures, including bridges and tunnels.

AI in Energy & Water Systems

Barcelona (Spain) – Energy–Water Optimization

•AI models optimize energy use in municipal water pumping and distribution systems.

•Integrates energy-demand forecasting with operational scheduling to lower carbon intensity.

- Source: *Barcelona City Council Smart City Projects* — barcelona.cat/smartcity

Melbourne, Australia — Smart water quality monitoring

AI is used for smart water-quality monitoring to forecast water quality, for protecting catchments with surveillance drones, and for creating digital twins to optimize recycled water.

Energy cost reduction: Melbourne Water uses an in-house AI program called "Python" to optimize pump operations for energy efficiency.

•Melbourne Water (research & innovation): https://www.melbournewater.com.au/research-innovation

•Victorian Government Digital Twin Victoria (context for water/climate models): https://www.sro.vic.gov.au/dtv (search: “water”, “flood”)

Florida AI Infrastructure Initiatives

Tampa Hillsborough Expressway Authority is running an AI-powered expressway pilot: Vehicle-to-infrastructure communication—cars talking to the road, the road adjusting to traffic conditions.

In Downtown Tampa, Suffolk Construction uses robots and AI analytics on construction sites.

- **Predictive safety:** Suffolk uses a proprietary AI platform that analyzes job site data to predict and prevent potential safety incidents.
- **Robotics:** The company deploys robotic prototypes, such as Boston Dynamics' "Spot the Robot Dog," to autonomously patrol job sites. The robots perform image capture, laser scanning, and data collection, allowing supervisors to remotely monitor progress and potential issues in real time.
- **Leak detection:** An AI-powered water intelligence platform called WINT is used to detect and stop leaks during and after construction, preventing costly water damage.

Miami-Dade County

Miami's Brickell digital twin covers 10.5 square miles—one of the largest municipal digital twins in the U.S. Urban planners can simulate the impact of development before building anything. A partnership between the department, Dell Technologies and NVIDIA aims to create Miami's AI-driven urban metaverse

Florida AI Infrastructure Initiatives (Contd.)

Gainesville:
Gainesville partnered with the University of Florida to build an AI building permit tool. AI reviews building designs for code compliance and automatically flags issues. Speeds up the permitting process while maintaining safety standards.

Altamonte Springs:
Altamonte Springs was the FIRST city in the nation to use AI for site plan reviews. Faster approvals for economic development projects. Partnered with ETM Inc., a Gainesville-based company, keeping expertise in-state.

Naples:
Naples approved an AI chatbot named Fraser for permitting in July 2025—24/7 availability to answer questions and guide applicants through the permitting process. Citizen service—people can get help at 2 AM if that's when they have time. Reduces burden on city staff while improving service.

Fort Myers:
Fort Myers is using AI for asset management and capital planning. This is about making data-driven decisions on infrastructure investments. Where should we invest limited capital? AI helps prioritize based on condition, criticality, and impact.

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Michigan AI Infrastructure Initiatives

- **Detroit - M-1 Intelligent Corridor (Woodward Avenue):** Woodward Avenue is becoming a smart roadway with AI-powered cameras for real-time traffic flow monitoring, pedestrian safety, and accident detection. The goal is to reduce accidents—AI can spot dangerous situations faster than human operators. A central corridor through Detroit, so improvements here affect thousands daily.
- **I-94 CAV Corridor:** Smart roadway technology-enabled express lane. 39 miles connecting Detroit and Ann Arbor. This is about connected and automated vehicles—V2V (vehicle-to-vehicle) and V2I (vehicle-to-infrastructure). Roadside sensors and wireless equipment enable vehicles to communicate. Goals are improved safety, reduced congestion, and enabling automated vehicle testing.
- **Macomb County - Wastewater Infrastructure AI:**
- Using AI with drone-based inspection to monitor wastewater infrastructure. Proactive detection prevents future catastrophic failures.
- **East Lansing - AI-Powered Recycling:** This is a landmark program that uses computer vision on recycling trucks. Cameras monitor what goes in each bin, and AI detects proper vs. improper recycling. The system generates personalized educational postcards for residents—result: improved recycling rates and reduced contamination.

⚠ Key Challenges

Data Quality & Integration

Legacy systems, siloed data, inconsistent formats

Cost & Funding

High upfront investment, uncertain ROI timeline

Workforce Skills Gap

Need for AI literacy, resistance to change

Privacy & Security

Data protection, cybersecurity concerns

Governance & Ethics

Algorithmic bias, accountability, transparency

✓ Proven Solutions

Start with Pilot Projects

Prove concept at small scale before full deployment (Gainesville model)

Public-Private Partnerships

Leverage vendor expertise and share risks (Tampa THEA example)

University Collaborations

Access research, talent, and funding (UF partnership in Gainesville)

Phased Implementation

Incremental rollout with continuous evaluation

Training & Change Management

Invest in workforce development, emphasize AI as tool not replacement

Return on Investment & Measurable Benefits

💰 Cost Savings

- Netherlands: 30% maintenance cost reduction
- Barcelona: 15-25% energy cost savings
- Israel: Massive water loss prevention
- London: 40% reduction in emergency repairs

⏱️ Efficiency Gains

- Singapore: 15-20% congestion reduction
- Gainesville: Faster permitting process
- Naples: 24/7 citizen service availability
- Melbourne: 100x faster contamination detection

🛡️ Risk Reduction

- Copenhagen: 60% fewer flood incidents
- Japan: 99.9% railway reliability maintained
- Macomb County: Prevent catastrophic failures
- Seoul: Faster emergency response times

🌱 Sustainability Impact

- Stockholm: Reduced emissions through traffic optimization
- Toronto: Energy savings from adaptive lighting
- Barcelona: Lower carbon intensity in water systems
- LA: Better wildfire resource allocation

Typical ROI Timeline

Year 1-2: Implementation, training, initial data collection
Year 2-3: System optimization, early benefits realized
Year 3-5: Full operational efficiency, positive ROI achieved
Year 5+: Compounding benefits, continuous improvement

Conclusion: Hybrid Intelligence for Resilient Infrastructure

AI augments precision, prediction, and efficiency.

Human expertise ensures ethics, equity, and contextual validity.

Together, they enable resilient, adaptive, and sustainable infrastructure governance.

Key Takeaways

- AI in infrastructure is proven, not experimental
- Hybrid intelligence outperforms either alone
- ROI is measurable and substantial
- Success requires human-AI partnership
- Start small, scale strategically

Next Steps

- Assess current infrastructure needs
- Identify high-impact pilot projects
- Build partnerships (universities, vendors)
- Invest in workforce development
- Develop ethical AI framework

Additional Information

- Alibašić, H. (2025). Digital Intelligence for Effective Governance: AI in Administration. Springer. (In Print)
- Alibašić, H. (2024). The Post-Factual Polity: Ethical, Governance, Administrative, and Policy Crises in the Disinformation Era. IAP – Information Age Publishing Inc.
- Alibašić, H. (2022). **Strategic Resilience and Sustainability Planning: Management Strategies for Sustainable and Climate-Resilient Communities and Organizations.** Springer.
- Alibašić, H. (2018). **Sustainability and Resilience Planning for Local Governments: The Quadruple Bottom Line Strategy.** Springer.
- Alibašić, H. (2025). A Multi-paradigm Ethical Framework for Hybrid Intelligence in Blockchain Technology and Cryptocurrency Systems Governance. Fintech.
- Alibašić, H. (2025). Harmonizing artificial intelligence (AI) governance: A comparative analysis of Singapore and France's AI policies and the influence of international organizations. Global Public Policy and Governance, 5, 93–113
- Alibašić, H. (2025). Leveraging Hybrid Intelligence for Enhanced Sustainability and Resilience: A Comparative Analysis of Japan and South Korea. The International Journal of Sustainability Policy and Practice 21 (2): 1-29.

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