The Impact of Artificial Intelligence in Infrastructure Development[1]

Sinaye Mgolombane, MBA, PMP

Abstract

The world today has witnessed a myriad of wars and natural disasters that have left chilling memories of death and destruction. Destruction of the infrastructure critical to these countries' economies and elimination of expertise through death, that is vital in driving ID. Iran, Israel, Palestine, Russia, Ukraine, the Democratic Republic of Congo (DRC) and South Sudan are a case in point. Faced with this reality, many decades will pass without realising the infrastructure and economic recovery of these nations.

In circumstances where wars led to loss of human lives requiring expertise to rebuild their infrastructure and economy, will AI close the vacuum created by the loss of human expertise, thus expedite infrastructure recovery? This article reflects on possibilities of leveraging AI to advance and expedite the development, implementation, maintenance and governance of infrastructure projects.

Infrastructure Development (ID) is the process of creating and improving the fundamental physical and organizational structures and facilities that underpin a society's economy, well-being, and environment. These infrastructure systems incorporate transportation (roads, railways, airports, ports), communication networks, energy systems (electricity grids, power plants), water supply and sanitation. It also includes the soft infrastructure such as healthcare and education facilities.

ID is a vital, ongoing process worldwide. It fulfils the strategic importance for economic prosperity, social well-being, and sustainable development and remains a top priority for governments and international organizations.

ID globally faces a complex array of challenges, varying in intensity across regions but sharing common underlying themes. These challenges can present an impact on economic growth, social equity, and environmental sustainability worldwide. These challenges include funding and financing gap; ageing and inadequate maintenance; climate change and resilience; governance, corruption, and institutional weaknesses; project planning and delivery inefficiencies; Social and Environmental Considerations, etc.

Artificial intelligence (AI) is rapidly transforming the landscape of ID, offering significant opportunities to enhance efficiency, safety, and sustainability throughout the entire project lifecycle. From initial planning and design to construction, operation, and maintenance, AI

[1] How to cite this paper: Mgolombane, S. (2025). The Impact of Artificial Intelligence in Infrastructure Development, *PM World Journal,* Vol. XIV, Issue VIII, August.

is proving to be a powerful tool for optimizing processes and addressing complex challenges.

Keywords: Artificial Intelligence, Infrastructure Development, Project Management, Maintenance, Operations

Here's a breakdown of the key impacts of AI in ID:

1. Enhanced Project Planning and Design through:

- **Data-Driven Insights:** AI can analyse vast datasets, including historical project data, geological surveys, environmental conditions, and material specifications, to uncover hidden patterns and predict potential issues.
- **Generative Design:** AI-powered generative design algorithms can rapidly explore a multitude of design alternatives, considering various parameters like energy efficiency, structural performance, and material usage.
- **Risk Assessment and Mitigation:** By analysing historical data and real-time inputs, AI can identify and predict potential project risks, such as delays, cost overruns, and supply chain disruptions, allowing for proactive mitigation strategies.
- **Improved Scheduling:** AI-powered scheduling tools can optimize project timelines, accounting for factors like weather conditions, labour availability, and material deliveries, and dynamically adjust schedules as conditions change.

2. Optimized Construction and Project Management through:

- **Real-Time Progress Tracking:** Computer vision and drone technology, powered by AI, can monitor construction progress in real-time, identify deviations from plans, and provide detailed reports to stakeholders.
- **Automated Workflows and Robotics:** AI can automate repetitive and labour-intensive tasks, such as data entry and document management. Robots equipped with AI can perform tasks like bricklaying with increased speed and accuracy, enhancing productivity and reducing labour costs.
- **Site Safety:** AI-powered safety monitoring systems can detect potential hazards, identify non-compliance with safety protocols (e.g., proper PPE usage), and alert site managers in real-time, significantly improving jobsite safety.
- **Quality Control and Inspection:** Automated inspection tools driven by AI can conduct consistent and less error-prone quality checks throughout the construction process.

3. Advanced Operation and Maintenance through:

- **Predictive Maintenance:** AI can analyse sensor data from infrastructure assets (bridges, roads, pipelines, etc.) to predict potential failures and schedule maintenance proactively. This reduces the operations downtime, enhances asset lifespan, and minimizes maintenance costs.

- **Structural Health Monitoring:** AI-powered systems can continuously monitor the structural integrity of infrastructure, detecting anomalies and potential issues before they escalate into major problems.
- **Traffic Management:** AI can optimize traffic flow in urban areas by analysing real-time data, predicting congestion, and suggesting alternative routes or adjusting traffic signals.
- **Sustainability and Environmental Impact:** AI can optimize resource usage, monitor energy consumption, and implement waste management strategies, contributing to more sustainable infrastructure practices.

4. Increased Transparency and Accountability through:

- **Data Accessibility:** AI-powered chatbots and natural language processing (NLP) can make complex infrastructure data more accessible to citizens and stakeholders, answering questions about project timelines, budgets, and contractors in plain language.
- **Fraud Detection:** Machine learning can detect suspicious patterns in procurement and bidding, helping to identify potential corruption or inefficiency.

While the value that AI can bring to ID is substantial, careful thought and planning is required to avoid unintended consequences.

Challenges and Considerations:

Despite the immense potential, implementing AI in ID comes with challenges:

- **Data Quality and Standardization:** AI models rely on clean, structured, and comprehensive data.
- **Skills Gap:** There's a need for a skilled workforce capable of developing, implementing, and managing AI solutions in the infrastructure domain.
- **Ethical Concerns and Bias:** AI systems trained on biased historical data can perpetuate and amplify existing societal biases.
- **Security and Privacy:** AI systems handle large amounts of sensitive data, raising concerns about data breaches and cyberattacks. Robust security frameworks are essential.
- **Integration with Existing Systems:** Integrating new AI solutions with legacy infrastructure systems can be complex.
- **Cost of Implementation:** The initial investment in AI hardware, software, and talent can be significant.
- **Regulatory Frameworks:** As AI rapidly evolves, regulatory and governance frameworks need to keep pace to ensure responsible and ethical adoption.

AI is still relatively new in the ID domain. As exponential developments are taking place daily, it is also important to consider how they can be applied.

Some of the Notable AI Developments in ID - South Africa and Globally:

South Africa is rapidly emerging as a significant player in AI infrastructure development, with substantial investments from both local and international tech giants. The country is positioning itself as an AI hub on the African continent, though challenges remain, particularly in local ownership and skills development.

South Africa now hosts four AI-focused data centres, placing it among the top 13 countries globally for AI compute infrastructure, even outpacing some developed nations like Taiwan and the Netherlands. These facilities are split between model training and inference.

Microsoft has committed a R5.4 billion expansion to its existing R20.4 billion infrastructure footprint, with a portion dedicated to providing AI and cloud skills training to 50,000 people (and an aim to reach one million South Africans by 2026).

The South African government is working on a national AI plan to align priorities and objectives.

Huawei is actively promoting its AI cloud offering, including AI-native cloud services, and its Cloud Matrix 384 supercomputing solution for large-scale AI model training, as well as the roll-out of its Pangu LLM. The focus is on building AI-native infrastructure to support AI adoption and provide necessary computing power.

Approximately 55% of South Africans have used Generative AI at least once, indicating a growing acceptance and interest in AI technologies.

We have also witnessed the use of the drones and the real time stationary cameras in the construction sites, to undertake the quality control and assurance activities thus minimizing the cost of quality and reducing the safety incidents in the delivery of ID projects.

At the Global sphere, we have recently evidenced the positive impact of some of these tools such BIM (Building Information Modelling), Digital Twins, Augmented reality, ChatGPT, Asana, Unmanned Arial Vehicles (UAVs-drones), etc. that are being applied for efficient and effective design; planning; real time monitoring and evaluation; and document management of projects. The proliferation of these technologies will further enable the infrastructure development professional's capacity to deliver effective and efficient infrastructure development services against the needs and expectations of society.

Conclusion

AI is revolutionizing ID by enabling smarter, more efficient, safer, and more sustainable practices across the entire lifecycle. The advancement of AI technologies and various partnership models by the industry, government, and academia will foster the future where AI is crucial in building and sustaining the infrastructure of tomorrow.

References

1. Why must Artificial Intelligence (AI) Infrastructure and governance evolve together? - The World Economic Forum (May 2025).
2. Generative design-Siemens Digital Industries Software
3. Top 10 Ways AI is Transforming Project Management in 2025 – Lillian Avent NC State University.
4. AI Best Practices for Project Management- Atlassian (September 2025).
5. AI in Construction: Automation, Budgeting and Cost Predisctions -DataGrid (February 2025).
6. Huawei Reaffirms AI Commitment to South Africa (July 2025).
7. Nuclear, AI, and Infrastructure in Focus (Business Africa) – Africa CEO Forum 2025

About the Author

Sinaye Mgolombane

South Africa

Sinaye Mgolombane is an accomplished Business Executive, Digital Transformation Champion, Project Management Professional, and Environmentalist with over two decades of diverse experience across the Transport, Financial, Construction, Defence, and petrochemical sectors. He has managed and led strategic complex and mega infrastructure development programmes in these industries and sectors. Currently, Sinaye serves as the Chairman of the Board of Directors for PMSA, a non-profit organization dedicated to the advancement of the project management profession in South Africa and Africa. He has recently been appointed by GAPPS (Global Alliance for the Project Professions) as the Director.

Sinaye is passionate about naturing talent within project management and business management fields by sharing his expertise using thought leadership platforms and lecturing. To distress from his demanding career, he spends his time with his family and on the golf course. He can be contacted at Chair@projectmanagement.org.za