Leveraging GeoAI

Powering the cities of tomorrow

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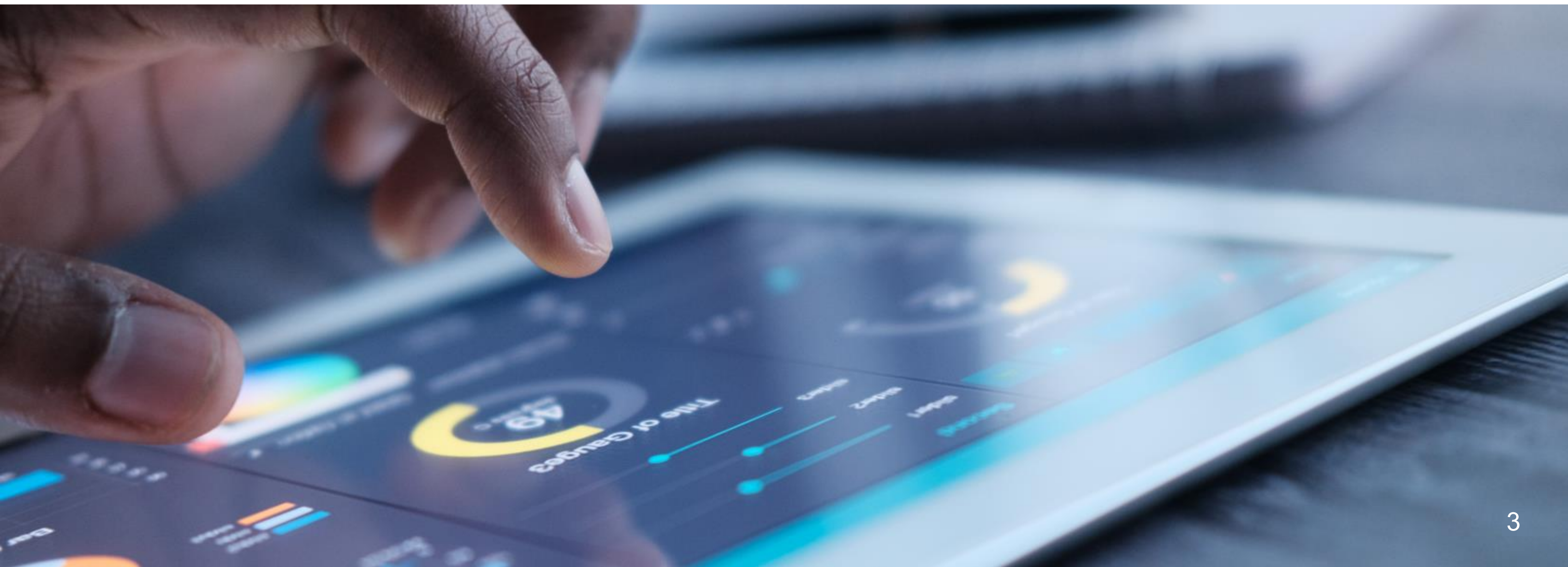
GeoAI for smart cities: Unlocking spatial intelligence for urban transformation

With the growing adoption of AI, it has become increasingly essential for city administrators to understand how AI can accelerate traditional geospatial technology to unlock spatial intelligence, deeper insights and real-time decision making.

GeoAI empowers smart cities to **unlock spatial intelligence** by combining the precision of geospatial data with the predictive and automating power of artificial intelligence. It can help urban planners and policymakers make smarter, location-aware decisions that improve infrastructure, utilities, emergency response and citizen centric services.

Designing a robust GeoAI solution requires thoughtful design and orchestration of different key technology components to ensure accuracy, scalability, interoperability and actionable spatial intelligence for smart city applications.

This thought leadership aims to offer a comprehensive understanding of GeoAI essentials, components and challenges. It provides a structured mechanism to help cities, modernise and transform their existing geospatial applications and enable them with AI to automate, predict and take better decisions.



Economic potential of GeoAI for smart cities globally and in Middle East

Smart cities which are being developed around the world are combination of greenfield and brown field development based on the specific needs of the country, existing infrastructure, budget and strategic priorities. The smart cities in Middle East region are growing at rapid rates driven by large government initiatives, substantial investment in urbanisation and adoption of advanced technologies like AI, IoT, 5G and cloud adoption.

The Middle East market for smart city is valued at US$70bn in 2024 and is projected to grow to US$312bn by 2035 at CAGR of 29% (2025-2035).

Geospatial technology and analytics serves as the backbone of smart city infrastructure, providing city planners and decision-makers with the tools they need to optimise urban planning, improve infrastructure management, and enhance citizen services. Over the past decade there has been rapid advancement in ICT which have significantly bolstered the field of geospatial analytics like launching of new sensors, reality capture technologies, rise of IoT, 5G and social media, enhancement of satellite, drones and image analysis, innovation in computing power and its affordability, convergence of geospatial analytics with AI (GeoAI) and evolution of geospatial analytics platforms.

The Middle East market for GeoAI is valued at US$57m in 2024 and is projected to grow to US$222m by 2030 at CAGR of 19% (2024-2030).

Smart cities market growth: A rapid transformation

	Global [1]	Middle East [2]
Market size (2024)	US$767bn	US$70bn
Projected market size (2035)	USD 4647 billion	US$312bn
CAGR (2025-2035)	25%	29%
Key growth drivers	Urbanisation, sustainability, digital infrastructure	Government initiatives, urbanisation, digital transformation
Fastest growing region	Asia-Pacific, North America	Saudi Arabia, UAE, Qatar

GeoAI Global & Middle East Market overview

	Global [3]	Middle East [4]
Market size (2024)	US$38bn	US$57m
Projected market size (2035)	US$65bn	US$223m
CAGR (2025-2035)	9%	18%
Key growth drivers	Demand for real-time spatial analytics, advancements in ML and remote sensing	Government initiatives, urbanisation, digital transformation
Fastest growing region	North America and Europe leading in adoption and innovation	Saudi Arabia, UAE spearheading initiatives with investments in GeoAI technologies

In the next few section, we will focus on the convergence of geospatial analytics with AI, role of GeoAI in smart cities, components of GeoAI, use cases, challenges and framework for implementing GeoAI for smart cities.

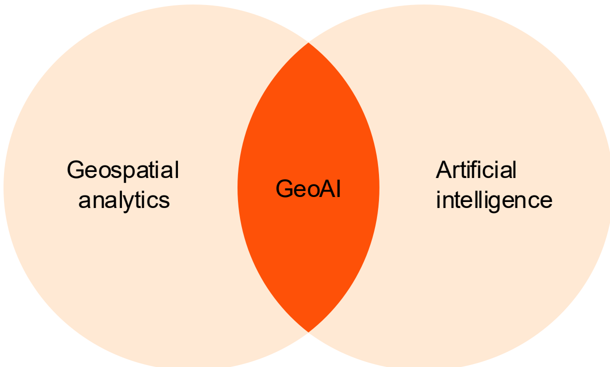
Convergence of geospatial analytics with AI

Geospatial analytics is the science of analysing geographical and spatial data to identify patterns, trends and relationships between different assets, people or places. It integrates remote sensing, Geographic Information System (GIS), Global Position System (GPS) and big data to analyse location-based information across multiple dimensions to produce outputs in the form of maps, graphs, statistics and cartograms. Geospatial analytics has been traditionally used by urban planners, transportation engineers, utility experts, environmentalist and city administrators for planning, designing, constructing and managing smart cities.

GeoAI is an amalgamation of geospatial data, science and technology with AI to extract meaningful insights and solve spatial problems.

If we consider AI as the development of machines that can think and reason like humans, GeoAI represents an intersection of AI and geography in developing advanced systems that make use of geospatial big data to perform spatial reasoning and location-based analysis, much like humans.

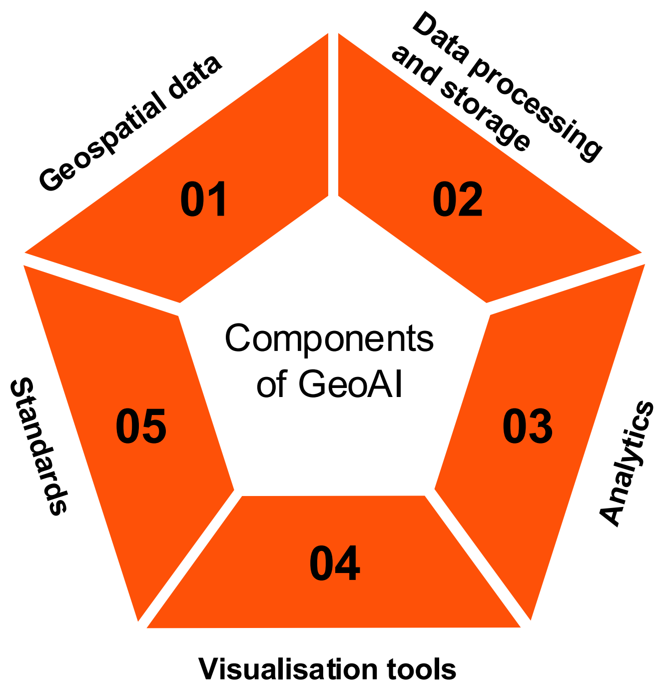
GeoAI combines predictive, prescriptive insights with geospatial data from drones, satellite imagery and helps to solve the problem in spatial context. It also helps to automate geospatial analytics to make them autonomous and work with minimum human supervision. GeoAI brings the geographic context to solve real world problems using multiple AI techniques object detection, spatial optimisation, natural language processing, integration with multiple data sources, etc.



Components of GeoAI

The recipe for developing, implementing an effective and robust GeoAI solution should include all the key ingredients like geospatial data, geospatial analytics, AI, ML algorithms, data processing, storage, visualisation tools, data integration, interoperability standards and ethical regulatory frameworks.

Components of GeoAI



The table below shows how each component can be supported by industry standard open source or proprietary tools/platforms.

Component	Supported tools, platforms and standards
Geospatial data	Raster data can be created from different types of sensors like Satellite, Drone, Aerial, etc. Vector data can be created by digitising raster data or by taking measurements of earth's surface or assets through different surveying techniques like total station, GPS, LiDAR, etc.
Data processing and storage	Open-source platforms: OpenStack, CloudStack, Eucalyptus, Open Horizon, EdgeX Foundry, etc. Proprietary platform: Amazon Web Services, Microsoft Azure, Google Cloud Platform, IBM Cloud, Oracle Cloud, NVIDIA Jetson, Microsoft Percept, etc.
Analytics	**Geospatial analytics** Open-source platforms: QGIS, GRASS GIS, PostGIS GeoServer, SAGA GIS, R with spatial packages Proprietary platform: Esri ArcGIS, Hexagon Geomedia, ERDAS IMAGINE, Bentley Maps, etc. **AI, ML, algorithms, techniques** Open-source platforms: TensorFlow, PyTorch, Apache Spark MLlib, Scikit-Learn. Proprietary platform: Google Vertex AI, AWS SageMaker, Azure AI, IBM Watson, OpenAI, NVIDIA Jetson, etc.
Visualisation tools	Open-source platforms: QGIS, GRASS GIS, PostGIS GeoServer, SAGA GIS, R with spatial packages, Cesium, Unity, Google Earth, etc. Proprietary platform: Esri ArcGIS, Hexagon Geomedia, ERDAS IMAGINE, Bentley Maps, PowerBI, Tableau, Microsoft HoloLens, etc.
Standards	Interoperability standards: International Organisation for Standardisation (ISO), World Wide Web Consortium (W3C) and Open Geospatial Consortium (OGC) standards Ethical and Regulatory Frameworks: Organisation for Economic Co-operation and Development (OECD) AI Principles, UNESCO AI Ethics Recommendation Data protection and Privacy laws: General Data Protection Regulation (GDPR), Personal Data Protection Law (PDPL) Cyber laws: National Institute of Standards and Technology (NIST) Cybersecurity Framework, KSA Essential Cybersecurity Controls (ECC)

GeoAI use cases in smart cities

The rise of GeoAI in the context of smart cities reflects a global shift toward data-driven urban transformation. In the Middle East, rapid urbanisation, climate resilience initiatives and national visions for digital innovation have positioned GeoAI as a key enabler of smarter, more sustainable cities. By combining geospatial intelligence with artificial intelligence, cities can harness real-time insights to enhance planning, optimise operations, and elevate citizen wellbeing.

Below are key applications of GeoAI in the smart city domain:

Use cases	Smart city components	Technology components	Benefits
Urban expansion analysis	Urban planning and land use pptimisation	Satellite imagery, machine learning models, historical growth data analysis	Informed zoning decisions, sustainable development, reduced urban sprawl
Traffic flow optimisation	Transportation, mobility	Real-time GPS, LSTM, traffic cameras, AI algorithms	Reduced traffic congestion, improved mobility, optimised traffic flow, lower emissions
Water leakage and pilferage detection	Utilities (water)	Satellite imagery, anomaly detection, deep learning, water meters data	Reduced water loss, optimised maintenance, conservation of resources, improve water billing
Real time flood simulation and prediction	Disaster management, resilience	DEM, hydrological model, GeoAI, live weather feeds, city drainage network	Early warning system, faster emergency response, better disaster preparedness, optimised evacuation
Environmental monitoring and climate action	Green environment, sustainable energy	Satellite imagery, IoT sensors, AI-driven forecasting models	Improved air and water quality, early warning systems, enhanced climate resilience
Public health and disease surveillance	Advanced healthcare, epidemiology	Disease outbreak mapping, Geo-tagged health records, AI-based trend analysis	Early detection of health risks, optimised healthcare delivery, localised interventions
Crime prediction and public safety	Secure cityscape, digital governance	Geospatial crime data, AI-based heatmaps, surveillance integration	Reduced crime rates, targeted policing, enhanced citizen safety
Smart energy grid planning	Sustainable energy, electric utilities	Geo-tagged utility data, AI load forecasting, remote sensing	Efficient energy distribution, minimised outages, improved energy sustainability
Citizen-centric services and personalisation	Digital governance, thriving economy	Geo-tagged user data, behavioral analytics, recommendation algorithms	Better citizen engagement, localised service delivery, improved quality of life
Sustainable infrastructure development	Intelligent Infrastructure, green environment	Spatial analysis, AI-based modeling, Infrastructure sensor data	Smart building, optimised land use, reduced environmental footprint
Solar potential mapping	Renewable energy, utilities	LiDAR, solar radiation models, spatial AI	Optimal solar panel placement, increased renewable energy use
5G network planning	Telecommunication	Network planner, geospatial analytics	Accelerates rollout, reduces deployment costs, and ensures optimal coverage and connectivity
Gas leak detection and monitoring	Gas	Satellite and drone imagery, IoT sensors, ML, location analytics	Safety enhancement, environmental protection, regulatory compliance

Challenges in GeoAI implementation

Implementing GeoAI solution for smart cities offers the possibility of increasing efficiency, availing resources appropriately and improving the level of intelligence in the use of available geo-spatial data. However, the approach for achieving these goals is fraught with different challenges...

01.

Data challenges

- **Limited open data ecosystems:** Many countries lack accessible, open geospatial datasets due to security and policy constraints
- **Data fragmentation:** Geospatial data is often siloed across government bodies, utilities, and private firms
- **Low historical data availability:** Smart city initiatives are new, so historical urban behaviour or satellite imagery is limited

02.

Technology and infrastructure

- **Integration with legacy systems:** Existing infrastructure lacks digital interfaces to integrate with GeoAI solutions
- **Limited real-time data infrastructure:** IoT sensor networks and cloud-based geospatial platforms are still under development in many areas
- **Initial investments:** Implementation of GeoAI system my require initial investments or technology refresh which can add additional costs to existing IT budget

03.

Human capital and skills challenges

- **Shortage of GeoAI experts:** There is a limited talent pool with expertise in both AI and geospatial technologies
- **Capacity gaps in public Sector:** Urban planners and government staff may lack training in AI and geospatial tools

04.

Regulatory and security concerns

- **Data privacy:** It is necessary to be cautious about privacy concerns when collecting consumer data and using it for analytical purposes
- **Cybersecurity risk:** Since GeoAI system are integrated to critical infrastructure they may be vulnerable to cyberattacks and hence required effective security measures
- **Regulatory compliance:** It is important to ensure that GeoAI systems meet the local and international standards, which may vary in some parts of the world

05.

Interpretability of AI models

- **Complexity:** Advanced GeoAI models are usually based on deep learning and sometimes it is difficult to explain their decisions making them act like "black box"
- **Accountability:** Lack of interpretability can lead to operational risks and reduced trust among stakeholders, especially in safety-critical applications. Hence it is important to use Employing Explainable AI (XAI) and using interpretable models, when possible, to address these concerns

06.

Ethical implications

- **Bias:** The training sets used in AI may contain different types of biases like geographical, selection, coverage, reporting, algorithmic, etc. It is important to consider localisation aspects and other relevant aspects for targeted implementation when considering training datasets
- **Job replacement:** Automation of survey, field inspections may result in workforce reduction which is likely to raise concerns among the workforces
- **Fairness:** It is important to distribute the benefits derived from AI derived insights e.g. uninterrupted power supply in rural and urban areas remains a challenge

PwC Middle East’s five step GeoAI implementation journey

To initiate an effective GeoAI solution, PwC Middle East has developed five step journey that empowers city administrators to implement GeoAI solution to optimise their planning, operations, improve predictive maintenance, lower costs, and foster sustainability throughout the city.

01. Define

- Identify core business challenges and classify them into different categories of planning, operations, maintenance, regulatory
- Align GeoAI initiatives with organisation strategic goals and objectives
- Current state assessment in four aspects: people, process, data and technology. Benchmarking your maturity against peers

02. Design

- Propose technical architecture for implementation of GeoAI applications
- Propose GeoAI use cases, tools, analytics addressing the business requirements
- Prepare an operating model for the organisation focusing on different aspects like governance structure, responsibility matrix, standards operating procedures, KPIs, risk management, training plan

03. Prototype

- Define objectives and scope of prototyping the GeoAI application with success criteria for implementation
- Develop and implement minimum viable product focusing on high impact use cases
- Conduct rigorous testing with real-world data to validate accuracy, performance and scalability

04. Scale

- Based on the feedback of prototype, modify the design considerations and update the technical architecture for implementation
- Implement the GeoAI solution and integrate it with existing IT applications
- Design the change management plan focusing on awareness, desire, knowledge, ability and reinforcement for seamless adoption

05. Monitor

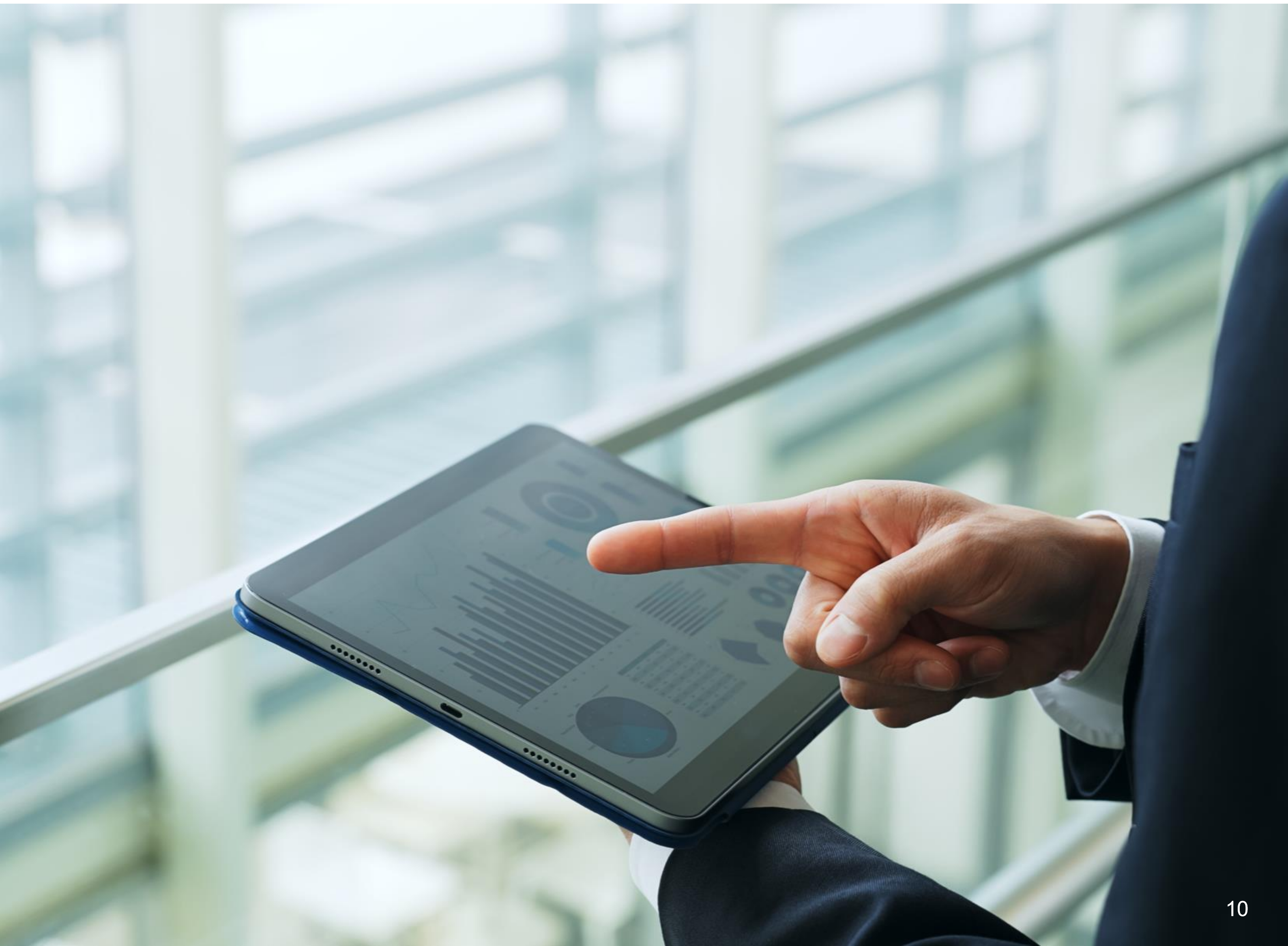
- Use performance tracking tools like dashboards to monitor system behaviour, data quality, output accuracy
- Optimise the processes, models, tools based on feedback received from different stakeholders
- Ensure infrastructure and architecture can support future growth in data volume, city areas, and functional scope

Way forward

City administrators are increasingly recognising the substantial economic and strategic value that GeoAI-driven solution across urban services and infrastructure.

However, many cities still struggle to implement a structured methodology to fully harness this potential. It is essential for cities to adopt a pilot approach that initially focuses on the GeoAI use cases that have the highest potential value and then based on feedback scale the solution for multiple functions in the city.

By harnessing the synergy of existing geospatial data and artificial intelligence, city planners and administrators can proactively manage infrastructure, optimise resource use, enhance public services and improve urban resilience. As cities face multiple challenges from rapid urbanisation to climate change, GeoAI provides strategic advantage, enabling data-informed decisions that foster sustainable, inclusive and livable urban environments..



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Contact us

Saed AlShaer
Partner, Digital Industries
PwC Middle East
saed.alshaer@pwc.com

Ahmad Abu Hantash
Partner, Technology Consulting,
PwC Middle East
ahmad.abuhantash@pwc.com

Imad Shahrouri
Partner, Cities Sector Lead
PwC Middle East
imad.shahrouri@pwc.com

Mohdsalam Alhomran
Director, Digital Industries
PwC Middle East
mohdsalam.alhomran@pwc.com

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