Smart Mobility as a Key Enabler of Smart Cities

Technologies, Governance, and Sustainability Challenges –
A Comprehensive Literature Review on Urban Transformation

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01. The Urbanization Challenge

02. Smart City Framework

03. SMART MOBILITY : a digital connector

04. Core Technologies

05. MaaS and Future Challenges

The Urbanization Crisis: Why Traditional Infrastructure is Failing

68% Urban Population by 2050

UN Department of Economic and Social Affairs projects massive demographic shift placing unprecedented pressure on city infrastructure and services.

Current System Pressures

Traffic congestion, declining air quality, energy strain, and infrastructure overload creating compounding urban management challenges.

Reactive Management Limits

Traditional approaches cannot scale with demographic growth. Cities need predictive capabilities rather than crisis response.

Smart City Strategic Response

Integrating ICT and sustainable energy solutions to transform urban efficiency and quality of life through data-driven decision making.

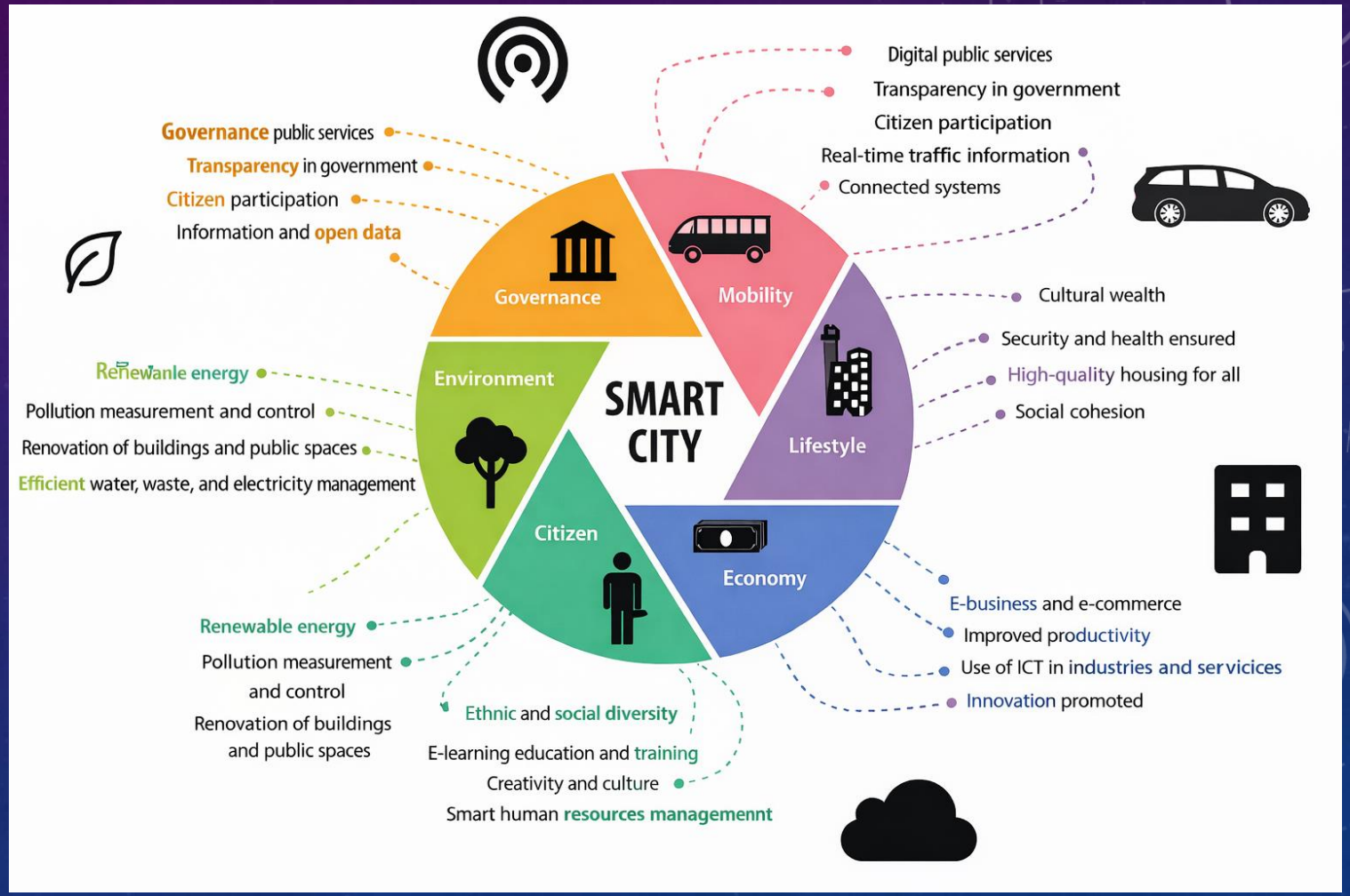
SMART CITY : six-pillar model

Six Interdependent Dimensions

Smart Economy, Smart Governance, Smart Environment, Smart Living, Smart People, and Smart Mobility form an interconnected urban ecosystem that relies on mutual reinforcement across all dimensions.

Mobility as Circulatory System

Without efficient transport flows, other pillars weaken. Mobility shapes access to services, influences economic performance, and underpins urban sustainability and resilience.



SMART MOBILITY : a digital connector

Beyond Vehicle Electrification

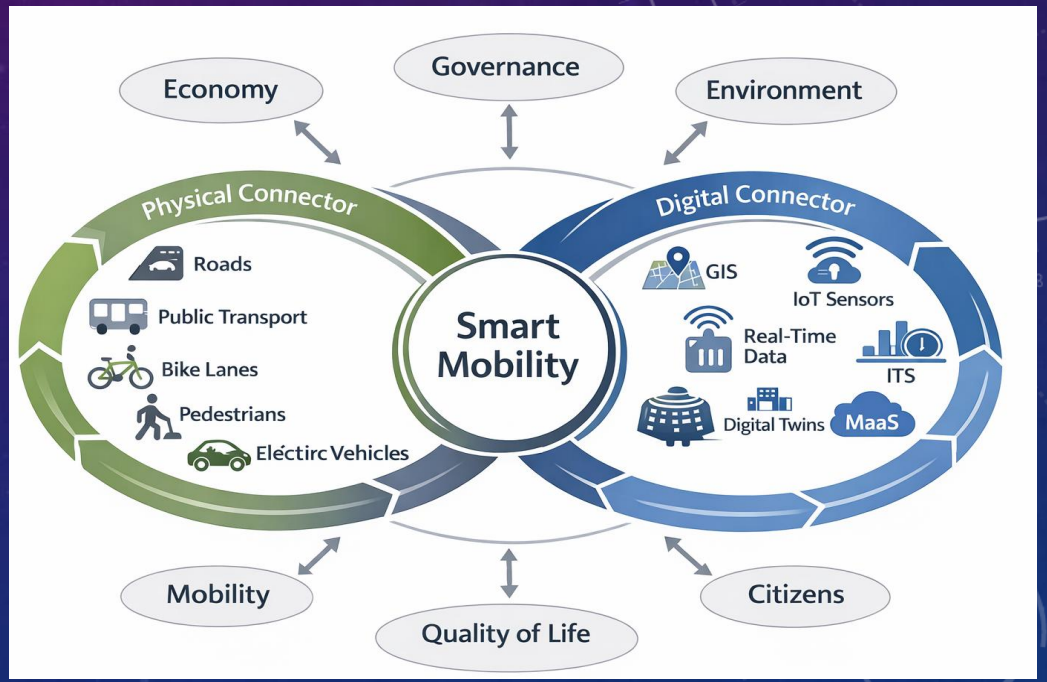
Smart Mobility is a digital intelligence layer overlaying physical space, not just technology adoption.

From Reactive to Predictive

Transforms static territory management into dynamic, predictive systems through real-time data analysis and geospatial intelligence.

Movement as Data

Every urban movement converted into usable data through GIS-based platforms, sensor networks, and digital collection systems.



Dual Connector Function

Acts simultaneously as physical connector (infrastructure) and digital connector (data flows) enabling integrated urban management.

The Technical Foundation: GIS, ITS, and Digital Twins Working in Synergy

GIS & Geospatial Intelligence

- Fine spatial-temporal precision for travel modeling.
- Enables dynamic traffic signal adjustment, public vehicle reallocation, and congestion forecasting with massive real-time geo-located data streams.

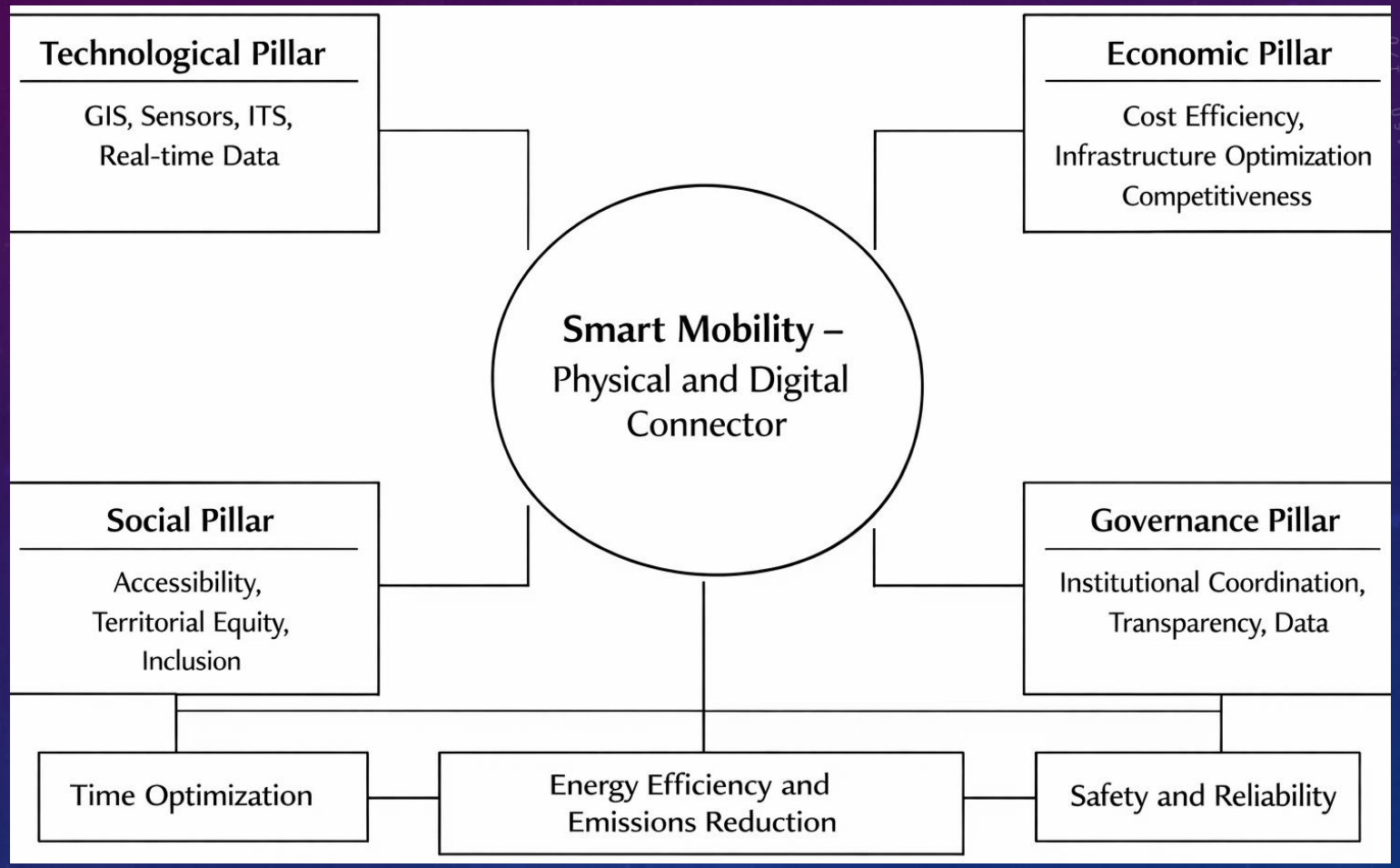
Intelligent Transportation Systems

- Converts data into concrete actions by linking infrastructure (*sensors, lights, signs*) with users.
- Automated intersection control, dynamic signaling, and real-time information services improve flow and safety.

Digital Twins Technology

- Virtual city replicas continuously fed by IoT sensors.
- Enables scenario testing (road works, accidents, traffic changes) before real deployment without disrupting daily traffic.
- Supports predictive transport management.

Four Pillars, Three Outcomes

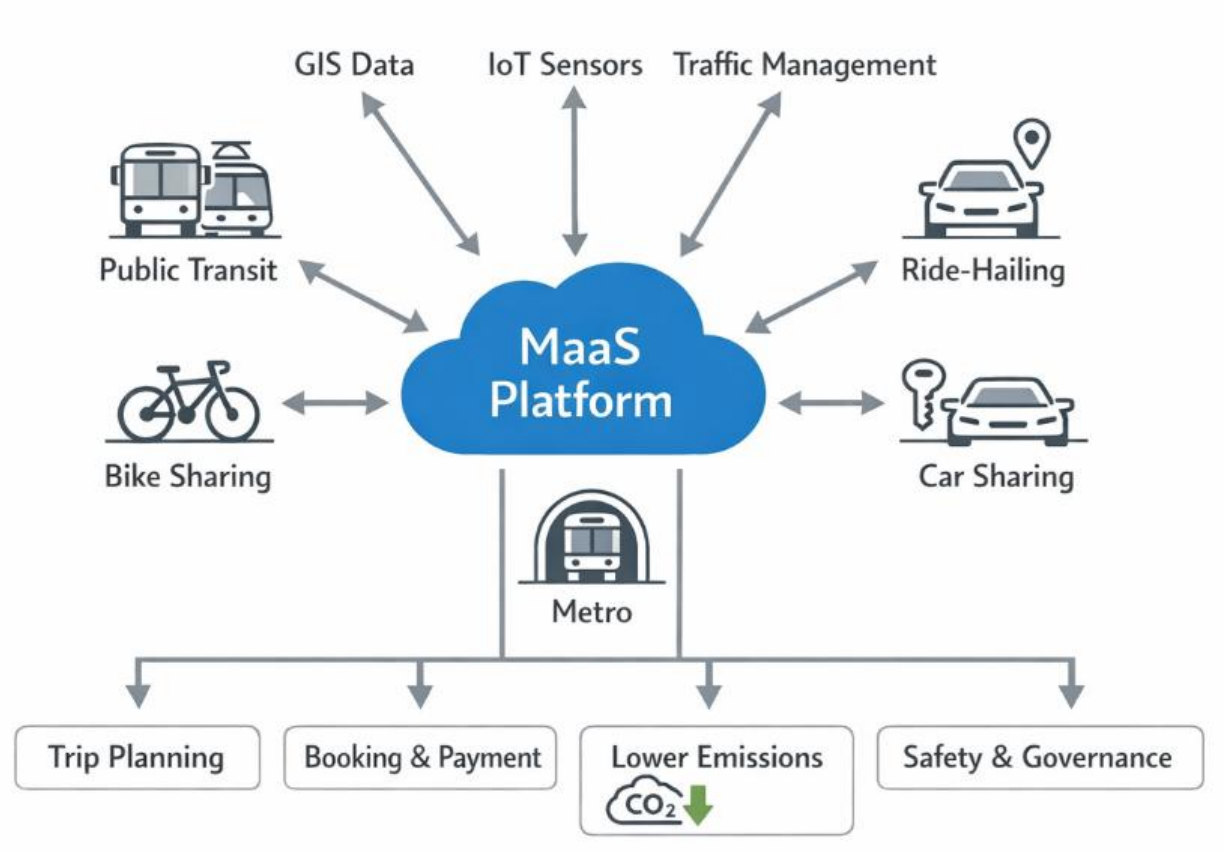


Time Optimization: Synchronized traffic signals and dynamic routing reduce trip duration and waiting times, increasing productivity.

Safety & Reliability: Better traffic visibility enables proactive interventions, reduces accidents, and makes public transport schedules predictable.

Energy Efficiency: Fewer unnecessary stops lower greenhouse gas emissions, supporting sustainability goals and MaaS transition.

Mobility-as-a-Service “MaaS” Platform



Leveraging Spatial-Temporal Data

Transforms GIS and sensor network data into actionable multimodal trip planning that adapts to congestion, incidents, and changing conditions dynamically.

Alignment with Smart Mobility Pillars

Time optimization through adaptive routing, energy efficiency via modal shift toward low-carbon options, and enhanced safety through continuous monitoring and coordination

Critical Challenges: The Gap Between Innovation and Implementation

Data Governance Tension

Centralized platforms create technological dependence and raise privacy violation risks. Need for transparent frameworks balancing optimization with citizen rights.

Territorial Inequality

City-wide average indicators mask disparities between well-served central neighborhoods and underserved peripheral areas. Solutions must address spatial justice.

Digital Infrastructure Readiness

Uneven deployment of sensor networks and data transmission systems limits effectiveness of digital twins and real-time management in many cities.

Social Inclusion Blindspot

Technical solutions often overlook actual usage patterns of marginalized populations. Risk of exacerbating inequalities through algorithmic bias.

Two Competing Paradigms: Systems Optimization *vs.* Sustainable Design

Systems Approach

- **Technological Efficiency**: Technology as direct solution.
- **Centralized Data Optimization** : Prioritizes system-wide efficiency.

User-Oriented Approach

- **Environmental Sustainability First** : Sustainability must be primary design constraint, not afterthought.
- **Resilient Inclusive Systems** : Avoid algorithmic biases of centralized models for social cohesion.

Adoption debate shows physical infrastructure (*connected bike lanes, pedestrian zones*) proves more powerful policy lever than individual psychology incentives or purely technological solutions.

FUTURE DIRECTIONS: TOWARD RESILIENT, INCLUSIVE URBAN MOBILITY SYSTEMS

Empirical Case Studies

Need real-world assessments of actual sustainability impacts beyond theoretical models. Measure greenhouse gas reductions, energy efficiency, and social equity outcomes.

Federated Data Models

Develop decentralized governance balancing privacy protection with optimization efficiency. Process data locally, aggregate learning without transferring raw information.

Integrated Frameworks

Combine fine-grained spatial analysis with multicriteria evaluation and meaningful citizen participation. Bridge gap between technological innovation and territorial equity.

Thank You For Your Attention

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