

Urban Planning, Sustainability, and Smart City Governance:

Strategic Diagnosis and Guidelines for the Municipality of Guarulhos (SP)

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Abstract— *The Brazilian urbanization process has evolved rapidly and unevenly, resulting in cities marked by profound territorial asymmetries and structural challenges related to urban sustainability. This article presents a strategic diagnosis of the municipality of Guarulhos (SP), integrating urban planning, sustainability, and smart city governance based on ISO 37120, ISO 37121, and ISO 37122 standards, as well as the Smart Lab Facens nine-axis framework. The research adopts a qualitative and exploratory approach supported by documentary analysis and benchmarking with municipalities in the state of São Paulo.*

The study identifies territorial heterogeneity, institutional fragmentation, mobility bottlenecks, environmental vulnerabilities, and limitations in digital governance integration. In addition, opportunities associated with technological modernization, urban innovation ecosystems, and collaborative governance mechanisms are discussed. The article proposes strategic guidelines and an evolutionary prioritization model capable of supporting the transition toward a more resilient, inclusive, efficient, and sustainable urban model.

Keywords— urban planning; smart cities; urban sustainability; Guarulhos; ISO 37120

I. INTRODUCTION

The urbanization process in Brazil consolidated rapidly and unevenly throughout the twentieth and early twenty-first centuries, producing cities characterized by territorial asymmetries, institutional fragilities, and structural challenges associated with urban sustainability. Cities may be understood as socio-spatial products shaped by multiple economic, political, environmental, and territorial dynamics that materialize unevenly across the territory [1].

Brazilian urbanization is characterized by the coexistence of highly valued urban areas alongside territories marked by precariousness, informality, and social exclusion. This process results from land concentration, selective real estate market dynamics, and the limited capacity of the State to implement inclusive urban policies [2]. Contemporary urbanization is directly associated with capital reproduction strategies, producing territorial fragmentation and socio-spatial segregation [3].

Located in the São Paulo Metropolitan Region, the municipality of Guarulhos stands out due to its economic relevance, high population density, and strategic logistical role driven by São Paulo International Airport. With a population exceeding 1.4 million inhabitants, the municipality combines strong economic dynamism with significant structural urban challenges [4].

The smart city paradigm has emerged as a contemporary approach capable of integrating technology, governance, sustainability, and social participation into urban management processes, aligned with ISO 37120, ISO 37121, and ISO 37122 standards [5]–[7]. This article aims to develop a strategic diagnosis of Guarulhos and propose guidelines for the construction of a more resilient, inclusive, and efficient urban model.

The originality of this study lies in integrating ISO smart city indicators, territorial diagnosis, governance assessment, and strategic prioritization into a unified analytical framework applicable to large metropolitan municipalities in emerging economies.

II. RESEARCH DESIGN AND METHOD

The research adopts a qualitative and exploratory descriptive approach structured through the integration of multiple analytical methods and data sources. Documentary analysis was conducted using the Municipal Master Plan (2023) and sectoral plans related to mobility, environment, housing, and economic development.

Secondary data were obtained from the Brazilian Institute of Geography and Statistics (IBGE) [4], SEADE Foundation [15], and the Environmental Company of the State of São Paulo (CETESB) [14]. The analysis was guided by ISO 37120, ISO 37121, and ISO 37122 standards [5]–[7], in addition to the Smart Lab Facens framework [12], [13], composed of nine strategic axes:

1. Education and Culture;
2. Energy;
3. Industry and Business;

4. Environment;
5. Mobility and Security;
6. Quality of Life;
7. Information and Communication Technologies (ICT);
8. Urbanization;
9. Governance.

Additionally, the study incorporated territorial diagnosis, SWOT analysis, the expanded triple helix model, and benchmarking with municipalities in the state of São Paulo.

The benchmarking process considered municipalities with comparable metropolitan relevance, demographic density, innovation ecosystems, and smart city initiatives. Sorocaba and Campinas were selected due to their recognized governance models, technological infrastructure, living labs, and institutional integration capacity. Comparative evaluation criteria included digital governance maturity, urban innovation ecosystems, mobility infrastructure, sustainability policies, public data integration, and collaborative governance mechanisms.

The SWOT analysis was operationalized through the crossreferencing of documentary evidence, territorial indicators, institutional reports, and infrastructure assessments. Internal dimensions focused on municipal capacities and structural limitations, while external dimensions considered technological trends, metropolitan dynamics, and climate-related risks.

The evaluation of the nine strategic axes adopted qualitative maturity criteria classified into low, medium, and high levels according to governance integration, technological adoption, institutional capacity, infrastructure conditions, and sustainability performance.

Additionally, the study incorporated elements inspired by the Santos 5.0 framework, emphasizing governance integration, citizen-centered digital transformation, urban intelligence, and sustainability-oriented innovation. The framework was adapted to the context of Guarulhos through phased implementation analysis, governance maturity assessment, and strategic KPI identification.

The methodological structure was divided into four analytical stages:

1. Territorial and institutional diagnosis;
2. Comparative benchmarking and SWOT assessment;
3. Strategic axis maturity evaluation;
4. Prioritization and implementation feasibility analysis.

Key Performance Indicators (KPIs) considered in the assessment included:

- public service digitalization rate;
- urban mobility efficiency;
- flood occurrence frequency;
- environmental vulnerability exposure;
- institutional interoperability;

- broadband and digital inclusion coverage;
- governance transparency indicators.

III. RESULTS AND DISCUSSION

A. Territorial Diagnosis

The territory of Guarulhos presents a complex urban configuration characterized by strong spatial heterogeneity. Consolidated urban areas coexist with peripheral regions marked by precarious urbanization, irregular occupation, and socio-environmental vulnerability.

São Paulo International Airport acts as a structural driver of the local economy, promoting economic dynamism and attracting investments. However, it also intensifies commuting flows and places pressure on the urban mobility system. The occupation of floodplain areas and soil impermeabilization contribute to recurrent flooding events, highlighting weaknesses in urban drainage infrastructure.



Fig. 1 — Location of Guarulhos in the São Paulo Metropolitan Region

B. Citizens' Needs

Based on socioeconomic indicators and territorial data, the following priority demands were identified:

- Improvement of urban drainage infrastructure;
- Implementation of monitoring and early-warning systems for climate events;
- Promotion of efficient and integrated urban mobility;
- Expansion of access to public services;
- Reduction of territorial inequalities;
- Expansion of digital inclusion;
- Strengthening transparency in public administration.

C. Governance and the Expanded Triple Helix

The transformation of Guarulhos into a smart city depends on the articulation among government, academia, private sector, and civil society. However, this integration still occurs in an

incipient and fragmented manner, representing a barrier to the implementation of innovative urban solutions.

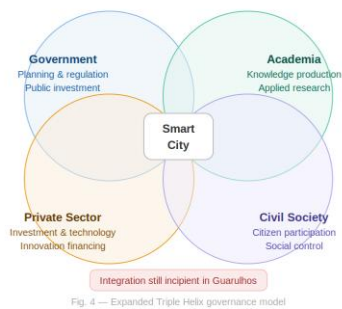


Fig. 4 — Expanded Triple Helix governance model

D. Strategic Axes Assessment

The analysis reveals heterogeneous conditions among the evaluated axes. Structural challenges are particularly evident in Mobility and Security, Environment, and Urbanization. Conversely, opportunities are identified in Energy, ICT, and Industry and Business. The Governance axis demonstrates the need for stronger institutional integration and strategic use of data.

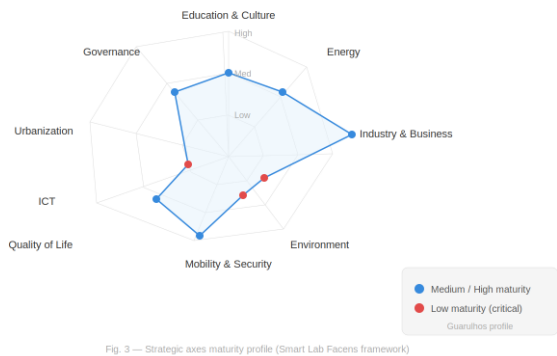


Fig. 3 — Strategic axes maturity profile (Smart Lab Facens framework)

TABLE I. SELECTED URBAN INDICATORS

Indicator	Guarulhos	Campinas	Sorocaba
Population	1.4 M	1.1 M	723 K
HDI	0.763	0.805	0.798
Urbanization Rate	98%	99%	98%

Flood Risk Areas	High	Medium	Medium
Smart Governance Maturity	Medium	High	High

E. SWOT Analysis

Strengths: strategic location and consolidated logistics infrastructure.

Weaknesses: territorial inequalities and inefficient mobility systems.

Opportunities: adoption of smart technologies and metropolitan integration.

Threats: extreme climate events and disordered urban growth.

F. Benchmarking and Lessons Learned

The comparative analysis with municipalities such as Sorocaba and Campinas indicates that the consolidation of innovation ecosystems — including technological parks and living labs — significantly contributes to the advancement of smart city initiatives [12], [13].

Guarulhos possesses relevant economic potential but still lacks structured innovation environments capable of accelerating urban technological transformation and collaborative governance processes.

G. Strategic Guidelines

The following strategic guidelines are proposed:

- 1. Strengthening integrated urban planning;
- 2. Implementation of urban monitoring systems;
- 3. Adoption of nature-based solutions;
- 4. Promotion of digital inclusion;
- 5. Integration of public data and systems;
- 6. Encouragement of urban innovation;
- 7. Strengthening collaborative governance.

The prioritization model is organized into three levels:

- Structural axes: Urbanization, Environment, Mobility, and Governance;
- Enabling axes: ICT, Health, and Energy;
- Consolidation axes: Industry and Business, Education and Culture.

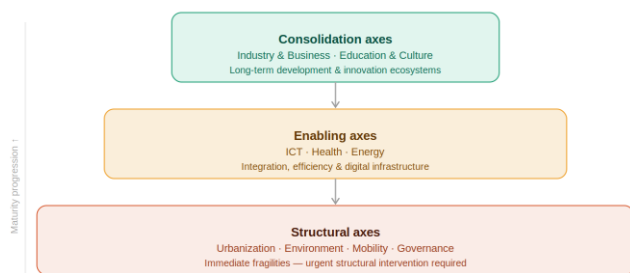


Fig. 2 — Evolutionary prioritization model (Smart Lab Facens nine-axis framework)

Fig. 2 — Evolutionary prioritization model

• TABLE II. STRATEGIC PRIORITIZATION

Axis	Urgency	Implementation Complexity	Strategic Priority
Mobility	High	High	Critical
Governance	High	Medium	Critical
ICT	Medium	Medium	High
Education	Medium	Low	Moderate
Environment	High	High	Critical

• H. Digital and Institutional Maturity

The municipality demonstrates progress in the digitalization of public services and administrative transparency [11]. However, there remains a need to evolve toward an integrated digital governance model characterized by interoperability between systems and strategic data management.

Short-term actions should prioritize governance integration, digital interoperability, and urban monitoring systems due to their relatively lower implementation complexity and higher institutional impact.

Medium-term initiatives should focus on drainage modernization, mobility integration, and climate resilience infrastructure.

Long-term strategies should consolidate innovation ecosystems, urban living labs, renewable energy transitions, and metropolitan-scale smart governance integration.

• I. Implementation Risks and KPIs

The implementation of smart city strategies in Guarulhos involves institutional, technological, financial, and socioenvironmental risks. The primary risks identified include:

- institutional fragmentation;
- discontinuity of public policies;
- budgetary limitations;
- unequal technological access;

- insufficient metropolitan coordination;
- climate-related infrastructure pressures.

To mitigate these risks, the study proposes a monitoring structure based on KPIs associated with governance efficiency, digital transformation, sustainability performance, and urban resilience.

• TABLE III. SMART CITY KPIs

KPI	Objective
Digital Service Coverage	Evaluate administrative modernization
Flood Response Time	Measure climate resilience
Public Transport Integration Index	Assess mobility efficiency
Open Data Availability	Evaluate governance transparency
Green Area per Capita	Monitor environmental sustainability
Broadband Access Coverage	Assess digital inclusion

The proposed governance model adopts a phased implementation structure inspired by the Santos 5.0 approach:

- Phase 1: Institutional integration and governance modernization;
- Phase 2: Infrastructure digitalization and interoperability;
- Phase 3: Urban intelligence consolidation and innovation ecosystems;
- Phase 4: Predictive governance supported by real-time data analytics and smart urban management systems.

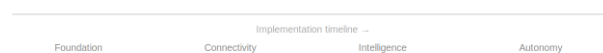
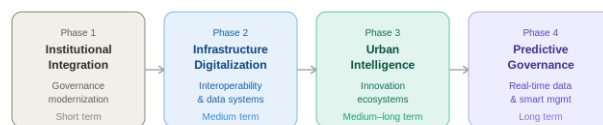


Fig. 5 — Phased implementation roadmap (adapted from Santos 5.0 framework)

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• IV. CONCLUSION

Guarulhos presents significant potential for the consolidation of a smart city model, although it continues to face

important structural challenges. The transition toward this model requires institutional strengthening, integrated planning, and commitment to territorial equity.

The proposed evolutionary model offers a strategic roadmap adaptable to local specificities, guiding the construction of a more resilient, inclusive, and sustainable city.

The incorporation of KPIs, phased implementation strategies, and governance maturity indicators strengthens the operational applicability of the proposed framework. In this context, the adaptation of Santos 5.0 principles contributes to the development of scalable and data-oriented urban governance models for metropolitan municipalities.

From a practical perspective, the proposed framework may support municipal managers in prioritizing urban investments and governance modernization strategies.

Academically, this study contributes to discussions regarding smart city governance in emerging metropolitan contexts characterized by socio-spatial inequality and institutional fragmentation.

Therefore, the proposed framework reinforces the importance of integrated governance, data-oriented decision-making, and territorial resilience as fundamental pillars for the sustainable transformation of metropolitan cities in emerging economies.

Future studies should investigate real-time urban indicators, digital twins, artificial intelligence applications in urban management, and metropolitan governance integration mechanisms.

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