Smart City Technology Master Plan (SCTMP): An Integrated Approach of the Smart Campus Facens Model in Osasco-SP

Ana Carla Castello
Independent Researcher
Mato Grosso do Sul, Brazil
acastello.br@gmail.com
ORCID: 0009-0001-2263-6187

Antônio Carlos Bussoni Filho
Gestão de Segurança Pública e Privada, UNIP Santana de Parnaíba
São Paulo, Brazil
carlosbussoni@gmail.com

Felippe Augusto Bergara
Engenharia Civil, Universidade Anhanguera de São Paulo
São Paulo, Brazil
fel_ippe@hotmail.com

Julia Rossato Oliveira Pereira
Serviço Social, UNESP – Universidade Estadual Paulista
São Paulo, Brazil
juliarossato.as@gmail.com

Luciano da Silveira Araujo
Independent Researcher
São Paulo, Brazil
dasilveira.araujo@gmail.com
ORCID: 0000-0002-8515-5882

Prof. Dr. Regiane Relva Romano
Facens – Faculdade de Engenharia de Sorocaba, Brazil
regiane@vip-systems.com.br
ORCID: 0000-0001-6185-2811

***Abstract*— *Sustainable urban management in Brazil faces significant hurdles due to information silos, low institutional trust, and fragmented decision-making across municipal sectors. This study proposes a Smart City Technology Master Plan (PDTCI) for Osasco, São Paulo, integrating the FACENS Smart Campus model — a Living Lab for urban innovation developed at Facens (Faculdade de Engenharia de Sorocaba) — with a centralized Intelligence and Governance Center (CIG). According to the IBGE, Osasco had 728,615 inhabitants in the 2022 census and a demographic density of 11,217.40 inhab/km², confirming the pressure placed on local public services [1]. The research adopts a quali-quantitative approach, combining a stakeholder survey, participatory diagnosis, and document analysis to identify priority urban challenges and institutional bottlenecks. The findings indicate low data interoperability (40%) and high institutional distrust (68%) as the main barriers to digital governance. Based on these results, the proposed CIG architecture is structured in five layers to support integrated decision-making, improve public service coordination, and strengthen citizen-oriented governance. Aligned with the Brazilian Charter for Smart Cities [2], the Smart Campus FACENS framework [3], and UN Sustainable Development Goals 11 and 16 [4], the PDTCI offers a replicable framework for medium-sized metropolitan cities seeking sustainable and participatory digital transformation.*

Keywords*— *Smart Cities, Digital Governance, Intelligence and Governance Center, Urban Transformation, Data Interoperability, Osasco.

I. INTRODUCTION

Osasco is one of the most economically relevant municipalities in the São Paulo Metropolitan Region. Official IBGE data place the municipality among the country's major urban centers, with 728,615 inhabitants in the 2022 census and a demographic density of 11,217.40 inhab/km² [1]. This high concentration of people, services, and daily commuting flows intensifies the demand for coordinated urban management and puts pressure on public safety, healthcare access, mobility, and flood risk response.

Despite its economic strength, Osasco still faces structural challenges related to fragmented administration and limited data integration across municipal sectors. In smart city terms, this means the city needs more than new technologies; it needs a governance model that can connect information, institutions, and citizens around shared priorities [5]. The Brazilian Charter for Smart Cities reinforces this direction by defining smart cities as planned, innovative, inclusive, and networked urban systems that use technology to solve concrete problems, reduce inequalities, and improve quality of life while ensuring the responsible use of data [2].

In this context, this paper proposes a Technology Master Plan for Smart Cities (PDTCI) built on the integration between the FACENS Smart Campus model and a centralized Intelligence and Governance Center (CIG). FACENS — Faculdade de Engenharia de Sorocaba — is a higher education institution whose Smart Campus operates as a Living Lab for Human, Intelligent, and Sustainable Cities, allowing real-world testing and replication of solutions relevant to smart cities [3]. The proposal also assumes compliance with the Brazilian General Data Protection Law (LGPD), which establishes rules for the processing of personal data and reinforces the need for privacy, transparency, and security in digital governance [6].

II. RESEARCH METHODOLOGY

This study adopts an applied, exploratory, and quali-quantitative design to diagnose urban challenges and structure a feasible smart city governance model for Osasco. The methodological strategy combines a bibliographic review of smart city frameworks [5], [7], an exploratory case study of the municipality, and a participatory diagnosis with local stakeholders.

A. Survey Design and Sample Stratification

The empirical phase was conducted between March and April 2025 through a survey of 75 respondents, selected to reflect Osasco's work-city dynamics. The sample was stratified by convenience into two groups: permanent residents (60%, n=45), who live in the municipality and use local public services daily, and daily commuters (40%, n=30), who work in Osasco but reside elsewhere, thereby exerting specific pressure on mobility and infrastructure.

The questionnaire assessed urban priorities using a 1-to-5 Likert scale, digital channel usage, and institutional trust. The 40% interoperability level was derived from mapping ten municipal secretariat APIs, of which only four possessed automated communication channels. The 68% institutional distrust index represents the proportion of respondents expressing low or very low trust in institutional digital channels. Data were analyzed using descriptive statistics and thematic interpretation. The study followed LGPD principles, especially data minimization, transparency, and responsible processing [6].

B. Modeling and Simulation Framework

For the design of the CIG model, the research used BPMN 2.0 to map operational flows and Monte Carlo simulation with 10,000 iterations to assess implementation scenarios and sensitivity to uncertainty. A prioritization matrix based on urgency, impact, and feasibility was applied to rank urban problems. The framework was also informed by the Brazilian Charter for Smart Cities [2] and Smart Campus Facens as a Living Lab reference [3].

III. DIAGNOSIS AND URBAN GAPS

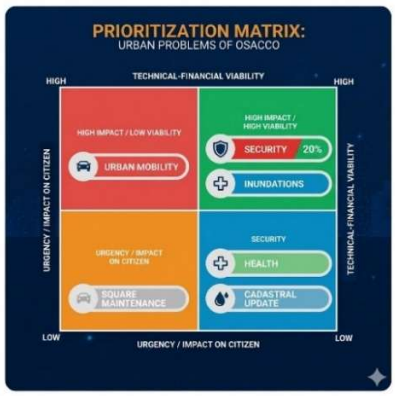
The diagnostic stage revealed a mismatch between Osasco's urban complexity and the current level of institutional integration. Although the municipality has high demographic density and strong economic relevance, its administrative and technological structures still operate in a fragmented manner, reducing coordinated action capacity [8]. This gap is critical in policy areas that depend on rapid information exchange, such as public safety, healthcare, mobility, and flood response.

The participatory diagnosis indicated that the city's main challenges are not limited to infrastructure deficits but also include low interoperability, weak coordination, and limited trust in institutional digital channels. The identified 40% interoperability level suggests a significant share of municipal data remains isolated in sectoral systems, making it difficult to build integrated responses to complex urban problems [9]. Politically, this fragmentation generates duplicated efforts, delayed responses, and low accountability. The same diagnosis indicates a high level of institutional distrust (68%), reinforcing the importance of transparent, citizen-centered, and accountable digital governance [10].

Survey responses showed that public safety and collective health were the most urgent priorities, while flooding appeared as a recurring structural concern linked to urban vulnerability. These findings are consistent with a smart city perspective that prioritizes concrete urban problems over technology adoption as an end in itself [5].

Fig. 1 presents the diagnostic matrix of Osasco's urban challenges, highlighting the main priorities identified in the participatory assessment.

Fig. 1 - Diagnostic Matrix: Urban Challenges in Osasco. Source:



Prepared by the authors (2025).

IV. THE INTELLIGENCE AND GOVERNANCE CENTER (CIG)

The proposed Intelligence and Governance Center (CIG) is designed as an integrated municipal hub for data coordination, service orchestration, and decision support. The proposed structure separates strategic decision-making, executive coordination, and sectoral implementation, enabling clearer accountability and faster interdepartmental response [11]. At the deliberative level, the Conselho Deliberativo (CDCIG) defines strategic directions and approves portfolios. At the managerial level, the Escritório Central (ECIG) operationalizes directives through specialized units, while the sectoral level organizes the Integrated Support Groups (GAIGs) as extensions within secretariats.

Fig. 2 illustrates the proposed organizational structure of the Intelligence and Governance Center (CIG), showing the deliberative, managerial, and sectoral levels.

Fig. 2 — Proposed organizational structure of the Intelligence and Governance Center (CIG).

Source: Prepared by the authors (2025).

Its architecture is organized into five synergistic layers that support data flow from field capture to executive visualization, enabling responsive and evidence-based governance:

1. **Sensing and Collection:** IoT devices, intelligent video monitoring, and environmental/hydrological sensors deployed across critical urban zones.
2. **Connectivity:** 5G in critical zones and a fiber optic backbone with end-to-end AES-256 encryption, including logical isolation of Civil Defense and video monitoring networks against cyber attacks [12].
3. **Analytical Processing:** AI (Machine Learning) and Big Data for predictive modeling, operating under strict LGPD compliance through anonymization algorithms and differential privacy to protect sensitive health and transportation data [6].
4. **Applications and Services:** Citizen-facing platforms for health, mobility, and transparency.
5. **Interface:** Executive dashboards and multimodal communication channels for decision-makers and the public.

Fig. 3 presents the CIG technical architecture with the five technological layers. The architecture follows a modular design where each layer communicates through standardized APIs, ensuring scalability and vendor independence. The Sensing and Collection layer captures real-time data from field devices; the Connectivity layer ensures secure data transmission; the Analytical Processing layer applies machine learning for pattern detection; the Applications layer delivers integrated services to end-users; and the Interface layer provides dashboards for managers and citizens [13].

Fig. 3 — CIG Technical Architecture

Source: Prepared by the authors (2025).

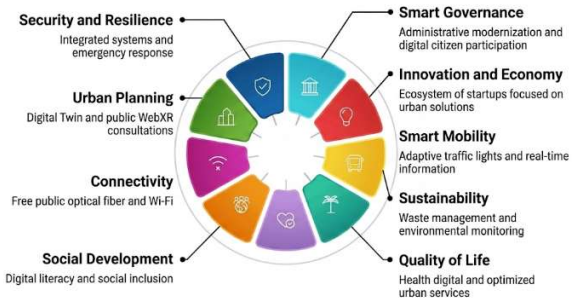
V. THE NINE STRATEGIC AXES OF TRANSFORMATION

The PDTCI is organized around nine strategic axes that connect municipal priorities, digital infrastructure, and citizen well-being: intelligent public safety, integrated urban mobility, quality of life, digital governance, innovation capacity, climate resilience, education and digital literacy, health coordination, and territorial inclusion.

Each axis corresponds to a recurring urban demand identified in the diagnostic stage. Public safety refers to monitoring and rapid response; urban mobility to interoperability and traffic management; quality of life to health and environmental monitoring; digital governance to transparency and accountability; innovation capacity to experimentation and learning; climate resilience to floods and emergency response; education and digital literacy to reducing exclusion; health coordination to service integration; and territorial inclusion to ensuring peripheral areas are not left behind.

Fig. 4 presents the nine strategic axes of transformation.

Fig 4 – The Nine Strategic Axes of Transformation



Source: Prepared by the authors (2025).

VI. STRATEGIC ROADMAP AND VIABILITY

Implementation is structured over a decadal schedule from 2026 to 2036 and is divided into three phases. The first phase focuses on the structuring of the CIG Hub and

the implementation of pilot actions in priority areas. The second phase expands the model to additional secretariats and scales the integrated services. The third phase consolidates advanced technologies and prepares the platform for long-term sustainability.

Phase 1, scheduled for 2026–2027, concentrates on governance formalization, limited pilots, and initial operational learning. Phase 2, scheduled for 2028–2032, broadens deployment through additional monitoring resources and wider cross-sector integration. Phase 3, scheduled for 2033–2036, incorporates frontier technologies such as blockchain and advanced AI, but only as a later-stage scalability layer rather than as the starting point of the model.

The total investment is estimated at R$ 120 million, with a projected ROI of 31% by 2040. This estimate should be interpreted as a scenario-based projection, since its realization depends on institutional continuity, governance stability, and the capacity to coordinate implementation across departments.

SWOT Analysis of the PDTCI Implementation in Osasco:

- **Strengths:** High municipal economic capacity and urban scale create favorable conditions for investment and institutional coordination. Osasco's GDP ranks among the top municipalities in São Paulo state, providing a solid fiscal base for smart city initiatives [1]. The existing Smart Campus FACENS partnership offers a proven Living Lab environment for testing solutions before municipal deployment [3].
- **Weaknesses:** Fragmentation of municipal data across isolated sectoral systems limits cross-departmental collaboration. Cultural resistance to decentralized governance persists among some administrative units, slowing adoption of integrated platforms. The current 40% interoperability level reflects years of independent IT procurement without a unified data strategy [9].
- **Opportunities:** Scaling a replicable smart city model aligned with the Brazilian Charter for Smart Cities [2] and the UN SDGs [4] positions Osasco as a reference for other medium-sized metropolitan cities. Access to federal smart city funding programs and international cooperation networks could reduce implementation costs. The growing demand for digital public services post-pandemic creates political momentum for transformation [10].
- **Threats:** Political volatility and electoral cycles may disrupt long-term implementation continuity. Cybersecurity risks increase with greater digital integration, requiring sustained investment in protection measures [12]. Implementation discontinuity due to budget constraints or shifting political priorities could erode institutional trust further.

Taken together, these factors indicate that the feasibility of the PDTCI depends not only on technology, but also on governance continuity, data governance, and institutional trust [11].

VII. INTEGRATED VISION OF THE SMART CITY: THE OSASCO PDTCI INFOGRAPHIC

Fig. 5 presents the integrated strategic vision of the PDTCI as a human-centered and sustainable smart city model. Unlike the organizational diagram of the CIG, this infographic synthesizes how the diagnosis of urban challenges, the governance structure, and the implementation axes are connected in a single operational framework.

The infographic highlights the relationship between the Intelligence and Governance Center (CIG), the Security Operations Center (SOC), the municipal data infrastructure, and the strategic axes of mobility, sustainability, public safety, and digital transformation. Its purpose is not to describe internal hierarchy, but to show how the plan operates as a system that links governance capacity to public value creation.

By consolidating technological pillars, governance mechanisms, and thematic priorities into one visual structure, Fig. 5 supports the transparency and communicability of the proposal. In this sense, the infographic functions as a strategic synthesis of the PDTCI and helps illustrate its role as a replicable framework for medium-sized metropolitan cities.

Fig. 5 – Infographic: Strategic Vision and Roadmap of Osasco's PDTCI

Source: Prepared by the authors (2025).

VIII. CONCLUSIONS AND RECOMMENDATIONS

The PDTCI demonstrates that Osasco's central challenge is not the absence of digital tools, but the need for an integrated governance structure capable of converting fragmented information into coordinated public action. By combining the Smart Campus Facens model with a centralized Intelligence and Governance Center, the proposal establishes a framework linking institutional

coordination, citizen participation, and digital service delivery.

Connecting results to Osasco's socioeconomic reality, the diagnosis reveals that high demographic density (11,217 inhab/km²) and economic relevance do not automatically translate into governance integration [1]. The identified 40% interoperability and 68% institutional distrust indices indicate structural barriers that require not only investment but also cultural and procedural change [9], [10]. The proposed CIG architecture, operating under LGPD compliance with differential privacy and AES-256 encryption, offers a technically feasible response aligned with SDGs 11 (Sustainable Cities) and 16 (Peace, Justice, and Strong Institutions) [4], [6].

The main contribution of the study is threefold. First, it offers a governance model tailored to a metropolitan municipality, bridging the gap between smart city theory and local implementation realities [5]. Second, it provides a phased roadmap allowing gradual implementation and scenario-based financial planning. Third, it reinforces that smart city transformation must be guided by interoperability, transparency, and citizen-centered governance rather than technology acquisition alone.

Formal recommendations include expanding data collection to peripheral zones, especially Osasco's North Zone, and explicitly including accessibility parameters for persons with disabilities. Pilot tests should be carried out over 6 to 12 months to evaluate social acceptance, operational feasibility, and real-world adjustment needs before broader scaling. Further studies should assess institutional conditions required for implementation, including governance continuity, interdepartmental coordination, and accountability mechanisms [11]. The PDTCI positions Osasco as a reference for democratic digital transformation and offers a replicable framework for medium-sized metropolitan cities seeking sustainable and inclusive smart city development.

REFERENCES

[1] IBGE, "Censo Demográfico 2022: Osasco," Instituto Brasileiro de Geografia e Estatística, 2023. [Online]. Available: https://cidades.ibge.gov.br/brasil/sp/osasco/panorama. Accessed: Apr. 10, 2025.

[2] Ministério do Desenvolvimento Regional, "Carta Brasileira para Cidades Inteligentes," Gov. Federal, Brasília, 2020. [Online]. Available: https://www.gov.br/mdr/pt-br/assuntos/desenvolvimento-urbano/carta-brasileira-para-cidades-inteligentes. Accessed: Apr. 10, 2025.

[3] R. R. Romano, A. C. F. F. Rodrigues, et al., "Smart Campus® as a living lab on sustainability indicators monitoring," in *Proc. IEEE Int. Conf. Smart Cities*, 2020, pp. 1–6.

[4] United Nations, "Transforming our world: The 2030 Agenda for Sustainable Development," UN General Assembly, A/RES/70/1, 2015. [Online]. Available: https://sdgs.un.org/2030agenda. Accessed: Apr. 10, 2025.

[5] M. Batty, "The age of the smart city," *Environ. Plan. B*, vol. 45, no. 1, pp. 3–6, 2018. doi: 10.1177/2399808317751686.

[6] Brasil, "Lei Geral de Proteção de Dados Pessoais (LGPD)," Lei nº 13.709, de 14 de agosto de 2018. Diário Oficial da União, Brasília, 2018.

[7] R. Kitchin, "The real-time city? Big data and smart urbanism," *GeoJournal*, vol. 79, no. 1, pp. 1–14, 2014. doi: 10.1007/s10708-013-9516-8.

[8] A. C. Castello, A. C. Bussoni Filho, F. A. Bergara, J. R. O. Pereira, and L. S. Araujo, "Smart City Technology Master Plan (SCTMP): An integrated approach of the Smart Campus FACENS model in Osasco-SP," MBA final project, FACENS, Sorocaba, Brazil, 2025.

[9] OECD, *Smart City Data Governance*. Paris, France: OECD Publishing, 2023. doi: 10.1787/9789264304420-en.

[10] OECD, "The OECD programme on smart cities and inclusive growth," OECD, 2019. [Online]. Available: https://www.oecd.org/en/about/programmes/the-oecd-programme-on-smart-cities-and-inclusive-growth.html. Accessed: Apr. 10, 2025.

[11] A. Meijer and M. P. R. Bolívar, "Governing the smart city: A review of the literature on smart urban governance," *Int. Rev. Adm. Sci.*, vol. 82, no. 2, pp. 392–408, 2016. doi: 10.1177/0020852314564308.

[12] NIST, "Framework for Improving Critical Infrastructure Cybersecurity," National Institute of Standards and Technology, Version 1.1, 2018. [Online]. Available: https://www.nist.gov/cyberframework. Accessed: Apr. 10, 2025.

[13] ABNT, "ABNT NBR ISO 37122:2020 — Cidades e comunidades sustentáveis — Indicadores para cidades inteligentes," Associação Brasileira de Normas Técnicas, Rio de Janeiro, 2020.