



Smart Urban Design with Intelligent Engineering Utilizing AI and Platform-Centric Analysis

Bhatraradej Boonsap Witchayangkoon¹, Yasser Arab^{2*}, and Alif Samsey^{1*}

¹Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, THAILAND.

²Department of Architectural Engineering, Dhofar University, SULTANATE of OMAN.

*Corresponding Authors (Emails: yarab@du.edu.om, fila_tu@hotmail.com).

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Abstract

The city of the twenty-first century is not just a group of buildings, roads, and infrastructure anymore. It has transformed into a living sensorium – a large, interconnected system that produces streams of data about movement, environment, energy uses, and human activities. Yet data alone does not create intelligence, and intelligence alone does not produce good design. The transformation of raw urban data into actionable design knowledge—from *smart data* to *smart design*—requires sophisticated analytical platforms, artificial intelligence, and perhaps most critically, a fundamental reorientation of how we understand the relationship between cities and their citizens. This paper presents a comprehensive analysis of the emerging paradigm of engineering cities that listen within the Thai context, examining how AI-powered platforms are being developed, deployed, and evaluated across urban Thailand over the past ten years (2015-2025). From peer-reviewed research, government pilot projects, industry case studies, and policy documents, this study traces the evolution from foundational data infrastructure through platform development to current deployments of AI-enabled decision support systems. The analysis looks at three interconnected areas. The first is the technology aspect of sensing, data sharing, and platform design. The second is the analysis aspect of AI-based inference, visualization, and decision-making support. The third is the governance aspect of institutional integration, citizen involvement, and policy coordination. Important findings show that Thailand has progressed from scattered pilot projects to a developing national framework, featuring notable innovations.

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1 Introduction

A city functions as a flow network of people, goods, water, energy, and information. The city of the twenty-first century has abilities to measure, model, and react to these flows in real time.

The increase of sensors, connected devices, and digital infrastructure has turned urban areas into extensive data-producing systems. This has created a paradox. That is, we know more about our cities than ever before, yet we find it increasingly difficult to use that knowledge for improved urban design and governance.

This paper explores this paradox through the concept of "listening engineering"—the creation of urban systems that can receive, interpret, and react to the signals produced by city life. The choice of the term listening is intentional. It indicates a perspective of the city not as a machine to optimize but as a dialogue to participate in. It suggests paying attention to signals that may be faint, unclear, or conflicting. It prioritizes the capacity to learn over the capacity to control.

In Thailand, the smart city agenda has gained attention over the past decade. With the national policies including Thailand 4.0, the Eastern Economic Corridor (EEC), and the Smart City Development Plan of the Digital Economy Promotion Agency (DEPA), municipalities and government agencies have launched pilot projects, built data platforms, and tested with AI applications. From the Bang Sue Smart City development in Bangkok to Phuket's mobility initiatives and Khon Kaen's provincial data dashboard, Thailand has emerged as a laboratory for smart city innovation in Southeast Asia.

However, the conversion of smart city investments into better urban design and planning results is inconsistent. Data platforms create dashboards, but these dashboards do not inherently lead to improved decision-making. AI models provide predictions, yet these predictions do not guarantee effective governance. AI models generate predictions, but predictions do not automatically produce responsive governance. The gap between smart data and smart design persists.

2 Literature Review

2.1 The Smart City Paradigm: Origins, Critiques, and Evolutions

The concept of the "smart city" has greatly grown since the early 2000s. The early idea focuses on the use of sensors, networks, and data analysis. These are the main drivers of urban efficiency and innovation. These technologies are seen in companies' projects. The examples are IBM's Smarter Cities and Cisco's Smart+Connected Communities. It can improve infrastructure systems like traffic management, energy use, waste management, and public safety.

There are many criticisms of this approach. Researchers indicate that this smart cities idea could turn citizens into mere data points, putting efficiency before fairness, and giving too much power to tech companies and data-keeping organizations. The Songdo International Business District in South Korea is often said as an early example of a smart city. This was too cautious of high-tech but lacked social warmth, with residents feeling less satisfied.

Smart city ideas have developed into frameworks that feature participation and their people. The idea of a "responsive city" lets urban systems to adjust to the needs and wants of peoples. "Platform urbanism" looks at how digital tools change urban economies, governance, and social

networking. Also, "data justice" brings attention to issues of power, inclusion, and rights using data for urban governance.

For Thailand, this evolution is seen in the contrast between early technology pilots and more recent initiatives that use institutional integration, citizen participation, and sustainable outcomes. The Samyan Smart City case study, examined by Phuangkawun (2024), clearly engages with international frameworks—comparing Thai methods to Songdo, Amsterdam, Medellín, and Silicon Valley—and concludes that successful smart city development requires "balancing technological advancement, community participation, and sustainability".

2.2 Urban Data Platforms: Architecture, Interoperability, and Governance

At the core of smart city projects is the urban data platform. This digital system is for gathering, saving, processing, and displaying data from many sources. These tools face major issues with data exchange: data from many sensors, agencies, and formats needs to be combined into clear, usable information.

Sangpetch et al. (2019) documented the development of an interoperable data platform for Thai smart cities, designed for IoT data exchanges for organizations through APIs. Their research identified a critical bottleneck: whereas data exchange mechanisms could be implemented technically, the process of identifying which data attributes were meaningful for visualization and decision-making remained stubbornly manual. Users/developers need to understand each data attribute and carefully select a few attributes to represent such a data stream. This manual process becomes a great impediment to scalability and productivity as the number of sensors and data streams multiplies.

For this challenge, Sangpetch et al. (2019) proposed an automated attribute inference approach using machine learning algorithms, achieving 87.15% accuracy with K-Nearest Neighbors classification. This work represents an early attempt to automate the translation from raw data to usable information—from "smart data" to what might be called "smart information."

The platform architecture question extends beyond technical design to governance. Who owns the data? Who can access it? For what purposes? These questions have become particularly salient in Thailand as multiple agencies—the Digital Economy Promotion Agency (DEPA), the Bangkok Metropolitan Administration (BMA), the Electricity Generating Authority of Thailand (EGAT), provincial administrations, and private sector partners—develop their own platforms with varying degrees of interoperability.

2.3 AI Applications in Urban Contexts: From Pattern Recognition to Decision Support

AI has expanded the possibilities of urban data analytics far beyond traditional statistical methods. Machine learning (ML) can identify patterns in complex data, forecast future conditions, categorize events, & suggest actions. In the urban context, the use of AI has surged in many fields.

Traffic management: AI's analysis of CCTV footage can identify traffic jams and violations, and improve signal timing. A pilot project in Bangkok showed how AI could find illegal parking using CCTV. This alerts the police and greatly boosts enforcement effectiveness. Likewise, Metthier's AI Traffic Control system, used at 72 intersections in Bangkok, links water gate data to help prevent flooding.

Environmental monitoring: AI systems can combine air quality, water level, and weather data to provide early warnings and inform responsive actions. Khon Kaen University's WaterWayWatch system automatically broadcasts flood warnings via Line and Telegram when water reaches critical levels.

Urban planning compliance: The PINUP platform, developed by students from KMITL and Chulalongkorn University, uses AI to analyze zoning regulations and generate compliant layout designs, reducing analysis time while improving decision accuracy. Mahasarakham University's Smart City Planning Platform (SCPP) uses AI-based change detection to identify unauthorized residential expansions in near real time, achieving 100% alert-to-action rates across 20 governance meetings over 300 days.

Building and facility management: Metthier's Intelligent Operation Center (MIOC) integrates over 12 building management systems across 15 buildings into a centralized dashboard, reducing operational costs by over 30%.

2.4 Participatory Governance and the "Listening City"

A tension in smart city literature is in the connection between data governance and democratic participation. Does the smart city give power to citizens or keep them under surveillance? Does decision-making based on data improve accountability or make it less clear? Do platforms open up new ways for people to participate or create new obstacles?

Phuangkawun's (2024) study of Samyan Smart City tackles these questions head-on, using the 3RC framework (Restrictive, Reflective, Rationalistic/Pragmatic) and Critical Schools of Thought to evaluate development strategies. The research shows the importance of balancing technological progress, community involvement, and sustainability. Also, it suggests creating processes that allow all groups of citizens to express their views and take part in decision-making.

The idea of the "listening city" implies this tension. Instead of seeing citizens as just data sources to be watched or users to be catered to, the listening city views citizens as active participants in a continuous dialogue about urban priorities, challenges, and opportunities. Listening means not just data collection but interpretation, response, and accountability.

In the Thai context, this orientation is visible in initiatives that prioritize alert systems and citizen feedback channels. Khon Kaen University's "Sri-alert" function broadcasts warnings directly to citizens via widely used messaging platforms. The Smart City Planning Platform integrates with governance processes such that alerts generate institutional responses—the documented 100% alert-to-action rate indicates a governance system that listens and acts.

2.5 Thailand's Smart City Landscape: Policy, Pilots, and Proliferation

Thailand's smart city agenda has been shaped by many policy frameworks and funding mechanisms. The Digital Economy Promotion Agency (DEPA) has created smart city development plans and certification criteria. The Eastern Economic Corridor (EEC) includes smart city components. The Smart JAMP (Japan-ASEAN Smart City) program has supported many Thai pilot projects since 2021.

The geographic distribution of smart city activity is notable. Bangkok has been the focus of multiple initiatives, including the Bang Sue Smart City development around the new Grand Central Station, traffic management pilots, and building management systems. Phuket has hosted mobility-focused pilots, including MaaS (Mobility as a Service) applications and AI-based traffic analysis. Khon Kaen has emerged as a significant provincial hub, with its Provincial Data Dashboard being expanded to five additional pilot provinces. Mahasarakham has demonstrated the feasibility of AI-GIS integration for planning compliance. Chonburi, particularly the Amata City industrial estate, has explored 5G-enabled smart bus and industrial applications.

This geographic diversity suggests both the vitality of Thailand's smart city ecosystem and the challenge of coordination. Platforms developed in one context may not transfer easily to another. Data standards may diverge. Governance capacity varies significantly across municipalities.

2.6 Infrastructure and Sustainability: The EGAT Eco Plus Case

The integration of smart city infrastructure with sustainability objectives is exemplified by EGAT's Eco Plus initiative. Thirasuppa (2019) developed a cloud infrastructure design model for green smart cities, focusing on resource allocation that maximizes renewable energy usage. Using linear programming, the model optimizes data center resource allocation to prioritize green energy sources, enabling calculation of green energy coefficients, carbon footprints, and sustainability metrics.

This research shows an important dimension of smart city development often overlooked in platform discussions: the physical infrastructure that digital systems has its own environmental footprint. Data centers consume high energy. The greenness of a smart city depends not only on what data is collected but on how computing resources are powered.

2.7 Research Gaps and Theoretical Framework

Despite growing research on Thai smart cities, many gaps remain. First, limited attention has been paid to the specific question of how data translates into design—the mechanisms by which urban analytics inform planning decisions and built outcomes. Second, the relationship between AI platforms and participatory governance remains undertheorized in the Thai context. Third, longitudinal evidence on the effectiveness of smart city initiatives is sparse, with most documentation focusing on pilot phases rather than sustained operation.

This paper addresses these gaps by adopting a three-layer analytical framework:

1. Technological layer: Sensing infrastructure, data exchange platforms, AI models, and visualization systems
2. Analytical layer: The translation of data into information, insight, and decision support
3. Governance layer: Institutional integration, decision processes, citizen participation, and accountability

By looking into smart city projects at these three levels, this analysis seeks to uncover both achievements and ongoing difficulties in the transition from smart data to smart design.

3 Methods

3.1 Research Design

This study uses a multi-method qualitative research design combining case study analysis with a systematic review of academic, technical, and policy literature. The case study method is for examining complex contemporary phenomena where the boundaries between technology, organization, and context are not clearly defined.

3.2 Case Selection

Six case initiatives were selected for in-depth analysis based on the following criteria: documented implementation in Thailand, availability of detailed information including performance data, diversity of geographic and sectoral contexts, and relevance to the "smart data to smart design" paradigm.

The selected cases are:

1. Mahasarakham University Smart City Planning Platform (SCPP): AI-GIS integration for planning compliance monitoring, with documented 300-day operational data
2. KMITL Interoperable Data Exchange Platform: IoT data platform with automated attribute inference for visualization
3. Khon Kaen Provincial Data Dashboard ("Khon Kaen Model"): Decision-support tool for provincial administration, expanding to six provinces
4. PINUP AI Zoning Platform: Student-developed AI system for zoning law analysis and space design assistance
5. Samyan Smart City: Mixed-use urban development integrating smart technologies with community participation
6. Bangkok Traffic and Parking Enforcement AI: AI-based detection of violations using CCTV infrastructure.

3.3 Data Sources

Data were taken from:

- ① Peer-reviewed academic publications: Including Sangpetch et al. (2019) on automated attribute inference and Boonlua et al. (2026) on SCPP outcomes

② Graduate theses: Including Phuangkawun (2024) on Samyan Smart City and Thirasuppa (2019) on EGAT cloud infrastructure

③ Government and agency documentation: Including Smart JAMP project reports from 2021-2024

④ University and industry publications: Including Khon Kaen University, KMITL, Mahasarakham University, Metthier, and SuperMap announcements

⑤ Competition documentation: Including the China-ASEAN Smart City Competition and Hylife Group innovation competition

3.4 Analytical Framework

Each case was analyzed in the three layers of the analytical framework (Figure 1).

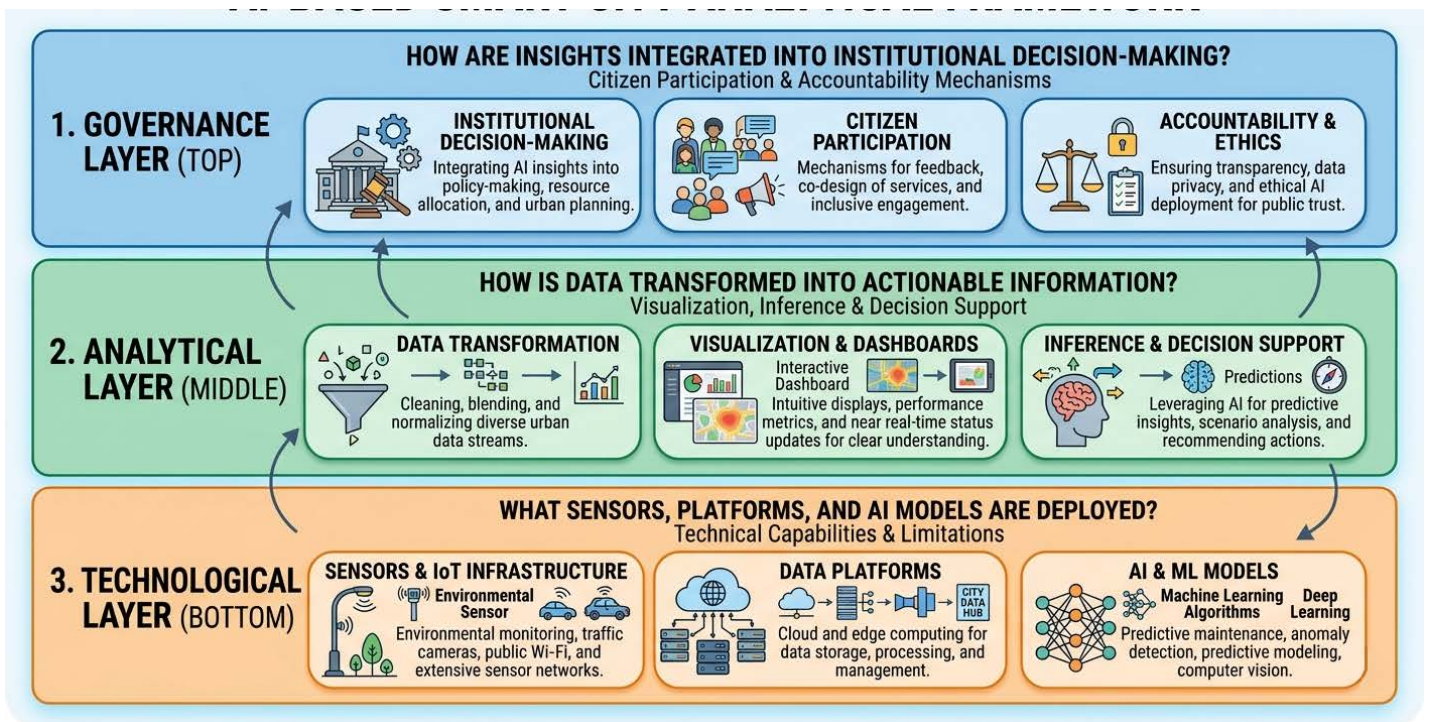


Figure 1: AI-based smart city analytical framework.

- Technological layer: What sensors, platforms, and AI models are deployed? What are their technical capabilities and limitations?

- Analytical layer: How is data transformed into actionable information? What visualization, inference, or decision support mechanisms are used?

- Governance layer: How are insights integrated into institutional decision-making? What mechanisms for citizen participation or accountability exist?

3.5 Limitations

This study has many limitations. First, reliance on published documentation means that unsuccessful initiatives or negative results may be underrepresented. Second, performance metrics are not standardized in all cases, limiting direct comparison. Third, the rapid evolution of

technology means that findings may date quickly. Fourth, the analysis necessarily simplifies complex, context-dependent phenomena.

4 Results

4.1 Chronological Evolution of AI-Powered Urban Platforms in Thailand (2014-2026)

4.1.1 2014-2017: Foundational Research and Early Pilots

The period 2014-2017 saw the establishment of foundational research on urban data systems in Thailand. Academic work focused on the technical challenges of data integration, visualization, and interoperability. Sangpetch and colleagues began developing the data exchange platform that would later be documented in their 2019 publication, establishing the importance of API-based interoperability for smart city data flows.

The Smart JAMP program, initiated through Japan-ASEAN cooperation, began supporting feasibility studies and pilot projects. Early work focused on understanding the specific challenges of Thai urban contexts, including traffic congestion in Bangkok and Phuket, and infrastructure management needs.

4.1.2 2018-2020: Platform Development and Policy Formation

By 2018, multiple platform initiatives were underway. EGAT's Eco Plus smart city project, studied by Thirasuppa (2019), exemplified the integration of sustainability objectives with cloud infrastructure design. The research produced linear programming models for green resource allocation that could be applied to smart city data center operations.

The Town and City Planning Act B.E. 2562 (2019) established Thailand's statutory planning framework, creating a regulatory context for digital planning tools. This legislative development provided impetus for platforms like SCPP that could align with official planning processes.

KMITL's data exchange platform demonstrated the technical feasibility of cross-organizational IoT data flows, though challenges remained in automating the visualization selection process. The automated attribute inference approach, achieving 87.15% accuracy with KNN, represented a significant advance in reducing manual overhead.

4.1.3 2021-2023: Pilot Expansion and International Collaboration

The Smart JAMP program expanded significantly during this period, supporting multiple Thai pilot projects. In Bangkok (2021-2024), initiatives focused on the Bang Sue Smart City development, traffic management, and parking enforcement. In Phuket (2021-2022), MaaS applications and AI-based traffic analysis were piloted. In Chonburi (2021), 5G-enabled smart bus technologies were explored. In Khon Kaen and other provinces, infrastructure management systems using AI image analysis were studied.

The ISC Bangkok 2022 event showcased South Korean smart city technologies, including TMS Platform for real-time decision management, Tiered AI for hierarchical video analytics, and e-DaaS for drone data integration. This event exemplified the international technology transfer dimension of Thailand's smart city development.

Samyang Smart City, studied by Phuangkawun (2024), was developed as a mixed-use urban project under Chulalongkorn University's Property Management Office. The project engaged with international case studies to inform Thai approaches, emphasizing the balance between technology, community, and sustainability.

4.1.4 2024-2026: Operational Deployment and Demonstrated Impact

The most recent period has seen platforms move from pilot to operational deployment with documented performance data.

Maharakham University's SCPP was piloted in an official urban planning assessment project in Maha Sarakham Province. The platform's 2026 peer-reviewed publication documented a 100% alert-to-action rate across 20 governance meetings over 300 days, demonstrating direct institutional impact. The platform uses AI-based change detection to identify unauthorized residential expansions in near real time, integrating with GIS for land-use compliance analysis.

Khon Kaen University's Provincial Data Dashboard, recognized by the Office of the Public Sector Development Commission (OPDC), has been authorized for expansion to Kalasin, Chiang Rai, Songkhla, Nong Khai, and Udon Thani. The dashboard provides provincial executives with empirical data on budgets, drought management, and public safety.

The PINUP platform, developed by students from KMITL and Chulalongkorn University, won first prize in the Smart Living & PropTech track of an innovation competition in November 2025. The platform features automatic reading and conversion of zoning laws using AI technology, AI-assisted layout generation, and 2D/3D design visualization.

Metthier's deployments at Government Complex Chaeng Watthana and BMA Command Center demonstrated operational scale: integration of over 12 building management systems across 15 buildings, and AI Traffic Control covering 72 intersections with integrated water gate data for flood prevention. The company reported labor and operational cost reductions of up to 30%.

4.2 Technological Layer: Platforms, Sensors, and AI Models

4.2.1 Sensing Infrastructure

Thai smart city initiatives draw upon diverse sensing technologies. Traffic monitoring relies primarily on existing CCTV infrastructure, augmented by AI analytics. The Bangkok parking enforcement pilot demonstrated that AI could detect violations from standard CCTV footage without new camera deployment. Similarly, Phuket traffic analysis used AI image processing of existing CCTV data to analyze traffic volume, origin-destination patterns, and vehicle trajectories.

Environmental sensing includes water level monitoring (Khon Kaen's WaterWayWatch), air quality monitoring (Government Complex PM2.5 sensors), and water gate sensors integrated with traffic systems (BMA Command Center). These sensors enable real-time alerting and automated responses.

Building management systems integrate multiple sensor types—HVAC, lighting, security, occupancy—into centralized platforms. Metthier's MIOC integrates over 12 systems across 15 buildings.

4.2.2 Data Exchange Platforms

The challenge of interoperability across heterogeneous data sources is addressed through API-based platforms. KMITL's platform, documented by Sangpetch et al. (2019), enables data exchange among organizations through microservice architecture and graph-based access control. The platform accepts data from legacy systems, proprietary systems, and standard APIs, translating diverse formats into usable information.

A critical innovation is the automated attribute inference system, which uses machine learning (KNN achieving 87.15% accuracy) to identify which data attributes should be visualized for users. This addresses the scalability problem of manual attribute selection.

4.2.3 AI Models and Applications

Thai smart city initiatives employ diverse AI applications:

- Change detection: SCPP uses AI to identify unauthorized residential expansions by comparing current imagery with baseline data
- Object detection and classification: Traffic systems detect vehicles, parking violations, and traffic flow patterns
- Predictive analytics: Water level monitoring enables flood prediction and automated gate control
- Natural language processing: Some infrastructure management projects have explored large language models for predictive maintenance
- Generative AI: PINUP uses AI for layout generation based on zoning constraints

4.2.4 Visualization and Decision Support

Visualization ranges from simple dashboards (Khon Kaen Provincial Data Dashboard) to 3D visualization systems (KMITL platform) to integrated governance interfaces (SCPP's alert-to-action workflow). The effectiveness of visualization depends not just on technical sophistication but on integration with decision processes—the SCPP's 100% alert-to-action rate reflects that alerts are routed to governance meetings with accountability for response.

4.3 Analytical Layer: From Data to Design

The translation of raw data into design-relevant information involves multiple analytical steps:

Detection: AI systems detect patterns of interest—a parking violation, a change in land use, a rising water level. Detection must balance sensitivity (catching true positives) with specificity (avoiding false alarms).

Classification: Detected patterns must be classified to trigger appropriate responses. Is this water level "caution" or "emergency"? Is this land use change "violation" or "permitted construction"?

Prioritization: Not all detected events require immediate response. Systems must prioritize based on urgency, impact, and available resources.

Recommendation: The most sophisticated systems move beyond detection to recommendation, suggesting specific actions to decision-makers.

Documentation and Accountability: For design decisions to be informed by data, the data and the analytical process must be documented in ways that enable review, verification, and accountability.

The SCPP platform exemplifies this analytical chain. AI change detection identifies potential violations. GIS analysis assesses compliance with land-use regulations. Prioritization rules determine which cases proceed to governance meetings. Documentation tracks alert-to-action outcomes, enabling a documented 100% response rate.

4.4 Governance Layer: Institutional Integration and Participation

4.4.1 Institutional Integration

The effectiveness of smart city platforms depends critically on integration with governance institutions. The SCPP's 100% alert-to-action rate was achieved not through automation alone but through integration with 20 governance meetings over 300 days. Alerts trigger institutional processes; those processes produce decisions; decisions produce actions.

Similarly, Khon Kaen University's Academic Service Bureau plays a "vital gear" role in taking university innovations and applying them at the local level. The Bureau works with provincial agencies and local administrative organizations to ensure that data dashboards inform actual governance decisions.

4.4.2 Citizen Participation

The relationship between smart city platforms and citizen participation varies across initiatives. Some platforms prioritize citizen alerting: Khon Kaen's "Sri-alert" function broadcasts warnings directly to citizens via Line and Telegram. This approach treats citizens as recipients of information rather than sources or decision-makers.

Other initiatives emphasize two-way communication. Samyan Smart City, based on Phuangawun's (2024) analysis, explicitly engages with community participation as a design principle, drawing lessons from international cases including Medellín's participatory approaches. The research recommends "designing processes that enable all groups of citizens to voice their opinions and participate in decision-making".

The PINUP platform represents a different mode of participation: democratizing design expertise. By making zoning analysis and layout generation accessible to non-experts, the platform potentially enables broader participation in design processes.

4.4.3 Public-Private Partnerships (PPP)

Private sector actors play significant roles in Thai smart city development. Metthier provides platform and robotics solutions to government clients. SuperMap provides GIS technology underlying SCPP. International technology transfer occurs through programs like Smart JAMP, which brings Japanese AI and infrastructure management technologies to Thai cities.

The governance implications of private sector involvement are complex. While private partners bring technical expertise and resources, questions of data ownership, algorithmic accountability, and long-term vendor dependence remain.

4.5 Cross-Cutting Themes

4.5.1 The Green Dimension

Sustainability is an explicit theme in several initiatives. EGAT's Eco Plus project integrates renewable energy optimization into cloud infrastructure design. Khon Kaen University's sugarcane bio-oil project addresses both agricultural waste and air pollution, converting discarded leaves into fuel while mitigating PM2.5 emissions. This integration of environmental and smart city agendas distinguishes some Thai approaches from purely technology-focused initiatives.

4.5.2 The Provincial-Rural Dimension

While Bangkok dominates smart city discourse, significant innovation is occurring in provincial contexts. Khon Kaen's dashboard is expanding to six provinces. Mahasarakham's SCPP was piloted in a provincial capital. This provincial dimension is important because Thailand's urban challenges extend beyond the capital, and solutions that work in Bangkok may not transfer directly to other contexts.

4.5.3 The Student Innovation Dimension

Notable innovations have emerged from student projects, including PINUP's AI zoning platform and the SCPP team's competition-winning entry. This suggests the importance of educational institutions as innovation sources and the value of competition-based funding mechanisms.

4.5.4 The International Dimension

Thai smart city development is significantly shaped by international collaboration. The Smart JAMP program with Japan has supported multiple pilots. Chinese GIS technology (SuperMap) underlies SCPP. South Korean technologies were showcased at ISC Bangkok 2022. This international dimension brings resources and expertise but also raises questions about local ownership and appropriate technology transfer.

5 Discussion

5.1 Understanding the Evolution: From Smart Data to Smart Design

The ten years of AI-driven urban platforms in Thailand show a trend of increasing sophistication: starting from basic research on data sharing, moving through trial runs of AI applications, to fully operational systems with proven governance effects. This development shows not only technological progress but also institutional learning—the growing realization that data by itself does not lead to improved design, and that platforms need to be put into decision-making processes.

The SCPP's reported 100% alert-to-action rate is especially noteworthy. It shows that when platforms are crafted for institutional integration—when alerts lead to governance meetings, and those meetings result in accountable actions—the shift from data to governance can be fully realized. This apprehends the essence of "listening": it's not just about identifying signals but also about acting on them.

However, the shift from smart data to smart design is still lacking in key areas. Design—the creative combination of multiple constraints into a physical form—demands more than just compliance checks and violation identification. It needs the ability to envision alternatives, assess trade-offs, and engage with values and preferences that may not be easily measurable. Current AI platforms are proficient in detection and classification; however, they are less advanced in fostering the creative, evaluative, and deliberative aspects of design.

5.2 The Three-Layer Framework: Identifying Gaps and Opportunities

Using the three-layer framework on Thai smart city projects shows areas of strength and weakness.

Technological Layer: Thailand has built strong technical capabilities, including interoperable data platforms, automated attribute inference, AI-driven detection systems, and integrated visualization tools. However, there are still gaps in real-time analytics at scale, predictive modeling, and integration of data sources.

Analytical Layer: The translation of data into actionable information has advanced significantly, particularly in domains like compliance monitoring (SCPP), traffic management (Bangkok pilots), and environmental alerting (Khon Kaen). However, analytics remain largely reactive rather than predictive or generative. The leap from "what is happening" to "what should we design" is still mediated primarily by human judgment.

Governance Layer: This is where the most significant variation exists. The SCPP's integration with governance meetings demonstrates what is possible. Other initiatives focus primarily on data collection and visualization, with weaker links to decision processes. Citizen participation mechanisms remain underdeveloped in most platforms, with information flowing primarily from city to citizen rather than bidirectionally.

LISTENING ENGINEERING FRAMEWORK FOR URBAN CITIES

From Smart Data to Smart Design: Engineering Cities That Listen Through AI and Platform-Based Analysis

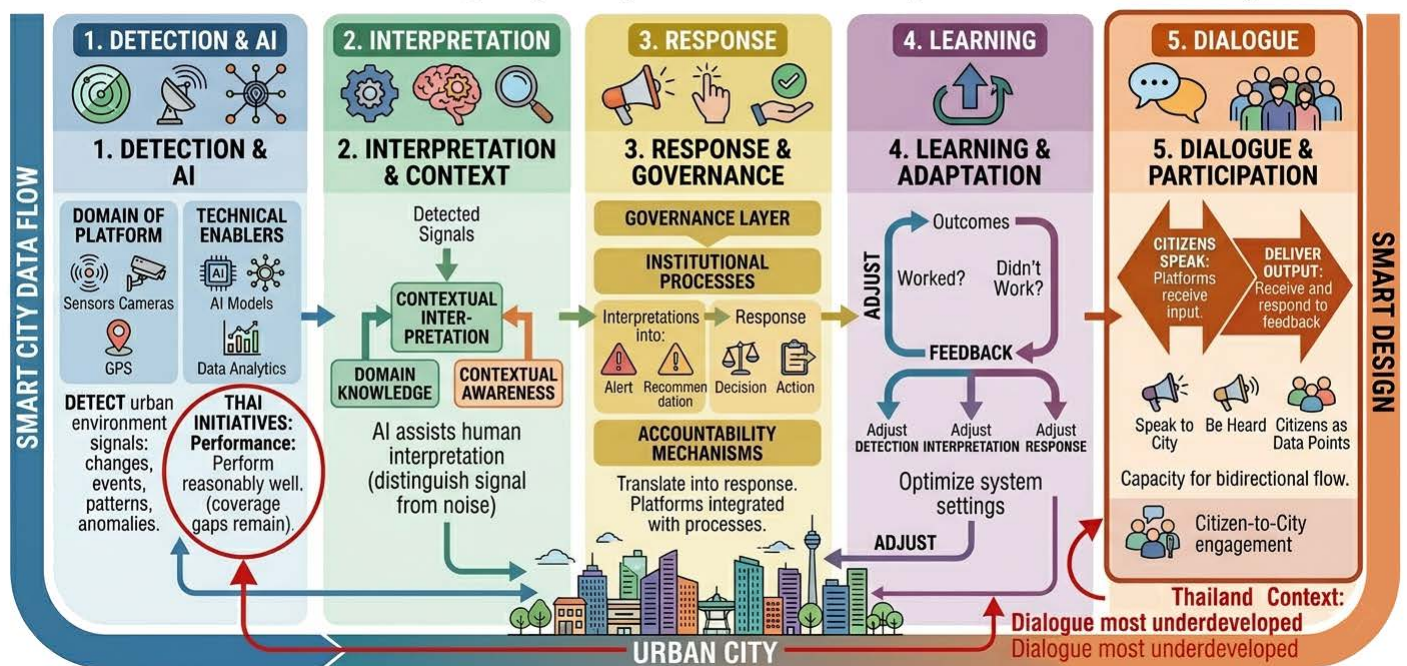


Figure 2: Listening Engineering Framework for Urban City from Smart Data to Smart Design.

5.3 The Listening Engineering Framework

The metaphor of "listening" suggests a framework for smart city practice (Figure 2).

Listening as detection: The platform must detect signals from the urban environment—changes, events, patterns, anomalies. This is the domain of sensors, AI models, and data analytics. Thailand's initiatives perform reasonably well here, though coverage gaps remain.

Listening as interpretation: Detected signals must be interpreted in context. What does this change mean? Is it significant? What are its implications? This requires domain knowledge, contextual awareness, and the capacity to distinguish signal from noise. AI can assist but not replace human interpretation.

Listening as response: Interpretation must translate into response—an alert, a recommendation, a decision, an action. This is the governance layer, where platforms must be integrated with institutional processes and accountability mechanisms.

Listening as learning: Responses produce outcomes. Those outcomes should be fed back into the system, enabling continuous learning and adaptation. What worked? What didn't? How should detection, interpretation, and response be adjusted?

Listening as dialogue: Finally, listening implies dialogue—the capacity for citizens to speak as well as be spoken about, for platforms to receive input as well as deliver output. This is the most underdeveloped dimension in current Thai smart city initiatives.

5.4 Implications for Urban Design Practice

For urban designers and planners, the rise of AI-powered platforms creates both opportunities and challenges:

Regarding opportunities, real-time data enables evidence-based design decisions, continuous monitoring of design outcomes, and rapid iteration. Compliance monitoring can be automated, freeing designers to focus on creative work. Participatory platforms could democratize design input.

For challenges, designers must develop new competencies in data literacy and algorithmic reasoning. They must navigate the ethical complexities of data-driven design, including privacy, bias, and accountability. They must maintain human-centered approaches in the face of technical optimization pressures.

The PINUP platform exemplifies one model: AI as a design assistant, handling the tedious work of zoning compliance so designers can focus on creative and contextual decisions.

5.5 Implications for Governance and Policy

Many policy implications emerge from this analysis. For interoperability standards, as multiple platforms develop across different agencies and municipalities, interoperability standards become essential. Without them, data silos will persist, and the promise of integrated urban intelligence will remain unrealized. For accountability frameworks, platforms that influence governance decisions require accountability frameworks. Who is responsible when an AI system produces a false positive or false negative? How are decisions reviewed? What recourse do citizens have?

For citizen participation mandates, current platforms emphasize top-down monitoring and alerting. Policy should mandate bidirectional communication, ensuring that citizens can provide input, raise concerns, and receive meaningful responses.

5.6 Implications for Technology Development

For technologists creating smart city platforms, many directions are proposed. In predictive analytics, the shift is from detection to prediction—foreseeing issues before they arise instead of just identifying them afterward.

For generative design, AI systems can produce design options within set limits, aiding rather than replacing human designers. By utilizing explainable AI, platforms can clarify their choices in ways that non-technical decision-makers and citizens can understand.

Privacy-preserving analytics allow for urban intelligence without sacrificing individual privacy. For affordable deployment, solutions are suitable for resource-limited municipalities, not only affluent urban areas.

5.7 Comparative Reflections: Thailand in the Regional Context

Compared to other ASEAN smart city initiatives, Thailand's approach has distinctive characteristics. The strong role of universities (Mahasarakham, Khon Kaen, KMITL, Chulalongkorn) as innovation sources distinguishes Thailand from more corporate-dominated models. The provincial dimension—innovation happening outside the capital—is also notable, as many ASEAN smart city discussions focus overwhelmingly on primate cities. The integration of sustainability agendas (EGAT, sugarcane bio-oil) differentiates Thai approaches from purely technology-focused initiatives.

However, Thailand shares common challenges with regional neighbors: interoperability gaps, governance fragmentation, capacity unevenness, and the persistent challenge of moving from pilot to scale.

6 Conclusions

Thailand has made substantial progress in developing the technical, analytical, and institutional capabilities for smart city implementation. From foundational research on data exchange in the mid-2010s to operational platforms with documented governance impact in the mid-2020s, the trajectory demonstrates cumulative learning and capability building. The SCPP's 100% alert-to-action rate over 300 days of operation represents a benchmark for platform effectiveness that should inform practice regionally and globally.

The translation from smart data to smart design remains incomplete and uneven. While platforms excel at detection, classification, and alerting, the generative and deliberative dimensions of design—imagining alternatives, weighing trade-offs, engaging with values—remain primarily human activities. AI serves as an assistant, not a replacement, for design judgment.

The three-layer framework (technological, analytical, governance) provides a useful diagnostic for assessing smart city initiatives. Thailand's strengths lie primarily in the technological layer, with growing capabilities in the analytical layer, and significant variation in the governance layer. The most effective platforms are those integrated with institutional decision processes and accountability mechanisms.

The "listening engineering" framework offers a productive orientation for future development. Listening implies not just detection but interpretation, response, learning, and

dialogue. Current platforms excel at detection; interpretation and response are developing; learning and dialogue remain underdeveloped.

The Thai experience demonstrates the importance of multiple innovation sources: universities, government agencies, private firms, international partners, and student projects. This distributed innovation ecosystem is a strength, but it also creates coordination challenges that interoperability standards and governance frameworks must address.

The provincial dimension of Thai smart city development is distinctive and valuable. While Bangkok attracts attention, innovation in Khon Kaen, Mahasarakham, and other provincial centers demonstrates that smart city capabilities can develop outside the capital and can address challenges relevant to the majority of Thai urban residents.

The integration of sustainability objectives with smart city development—evident in EGAT's green cloud infrastructure, Khon Kaen's sugarcane bio-oil, and water management systems—represents an important direction. Smart cities must be green cities; the two agendas should be integrated, not separate.

7 Availability of Data and Materials

All information is included in this article.

8 References

- Boonlua, P., et al. (2026). Smart City Planning Platform (SCPP) for Urban Planning Assessment in Mahasarakham Province.
- Chulalongkorn University. (2024). *Samyan Smart City Development*. Property Management Office.
- Digital Economy Promotion Agency. (2021-2025). *Thailand Smart City Development Plan*. Digital Economy Promotion Agency (DEPA), Bangkok: DEPA.
- Khon Kaen University. (2026). Smart City Operation Center (SCOPC) Showcase to Thailand Science Research and Innovation. *KKU News*, April 12, 2026.
- KMITL. (2026). *PINUP: AI Platform for Zoning Law Analysis and Comprehensive Space Design Assistance*. School of Information Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL).
- Metthier. (2026). *Metthier Elevates Thailand's Industries with AI and Robotics*. Metthier.co.th, March 31, 2026.
- Phuangawun, P. (2024). *Smart City Development: A Case Study of Samyan Smart City*. Chulalongkorn University Theses <https://digital.car.chula.ac.th/chulaetd/11460>
- Sangpetch, O., Sangpetch, A., Nartnorakij, J., & Vejprasitthikul, N. (2019). Automated Attribute Inference for IoT Data Visualization Service. In *Proceedings of the 9th International Conference on Cloud Computing and Services Science (CLOSER 2019)*, pages 535-542. SciTePress.

Smart JAMP (Japan-ASEAN Smart City) Program. (2021-2024). Thailand Project Documentation. Japan Association for Smart Cities in ASEAN. <https://st.jasca2021.jp/cooperative/country/thailand/>

SuperMap GIS. (2026). China-Thailand AI + GIS Collaboration Drives Innovation: Thai University Team Wins Third Prize at China-ASEAN Smart City Competition. *SuperMap News*, April 8, 2026.

Thirasuppa, R. (2019). *Cloud Infrastructure Design Model for Green Smart City: A Case Study of Electricity Generating Authority of Thailand*. Theses, Chulalongkorn University. <https://digital.car.chula.ac.th/chulaetd/9626>



Dr. Bhatraradej Boonsap Witchayangkoon is an Associate Professor of the Department of Civil Engineering at Thammasat School of Engineering, Thammasat University. He received his B.Eng. from King Mongkut's University of Technology Thonburi. He continued his PhD study at the University of Maine, USA, where he obtained his PhD in Spatial Information Science & Engineering. His interests encompass the application of emerging technologies within the field of civil engineering.



Dr. Yasser Arab is an Assistant Professor at Dhofar University, Sultanate of Oman. He obtained his Bachelor of Architecture from Ittihad Private University, Aleppo, Syria, and a PhD in Sustainable Architecture from Universiti Sains Malaysia (USM), Penang, Malaysia. His research focused on the Environmental Performance of Residential High-Rise Buildings' Façade.



Alif Samsey is a PhD student at the Department of Civil Engineering at Thammasat University in Thailand. He earned his Bachelor of Engineering in Civil Engineering from the same university. He obtained his Master of Engineering in Civil & Environmental Engineering from Gifu University, Japan. His research focuses on Social Engineering aimed at Improving People's Quality of Life.
