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SMART CITY DEVELOPMENT IN ASIAN COUNTRIES: CASE STUDIES AND POLICY IMPLICATIONS EMERGING ECONOMIES

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Abstract. As emerging economies in Asia face rapidly accelerating urbanization, the "smart city" concept has been widely adopted as a strategic solution to address infrastructure gaps and environmental pollution. However, the transition from ambitious national strategies to effective local implementation remains a critical challenge for emerging economies like Vietnam. In our study, we try to explain the development stages of smart cities in Asia, moving beyond the traditional techno-driven view to analyze the institutional and socio-economic dimensions of urban governance. Employing a comparative multi-case study approach, the research synthesizes experiences from established models (Singapore, Seoul) and emerging hubs (Jakarta, Indonesia) to identify success factors and potential pitfalls. The research reveals that successful Asian smart cities are characterized not only by advanced ICT infrastructure but also by robust smart governance frameworks, high levels of data interoperability, and active citizen participation. Conversely, over-reliance on vendor-driven technology solutions without parallel institutional reform often leads to digital silos and unsustainable investments. Based on the results, we propose a tailored policy framework for emerging economies like Vietnam that advocates a shift towards a data-driven, integrated planning approach, the institutionalization of sustainable financing, and the prioritization of human capital over purely physical infrastructure.

Keywords: Smart City; Asian Emerging Economies; Urbanization; Institutional Theory; Public-Private Partnership; Vietnam.

1. INTRODUCTION

Rapid urbanization in Asian emerging economies has created unprecedented pressure on infrastructure, positioning the "smart city" concept as a strategic imperative rather than a technological luxury. According to the United Nations, more than 65% of Asia's population is likely to live in urban areas by 2050, significantly intensifying demands on transportation networks and public services [1]. In many rapidly growing cities, persistent problems such as traffic congestion, inefficient logistics systems, and fragmented infrastructure planning have constrained urban productivity and quality of life [2].

Conceptually, this study adopts a systematic view of the smart city, moving beyond the early techno-centric definitions championed by technology vendors such as IBM and Cisco, which focused primarily on "instrumented and interconnected" systems [3], [4]. Instead, the research aligns with the human-centric approach, arguing that technology must serve as an enabler for social inclusion and sustainability [5], [6]. This view is operationalized through Giffinger et al.'s widely accepted framework, which defines smart cities through six dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living [7].

However, a critical review of current literature reveals a significant "institutional gap" in developing Asian economies. While established models like Singapore and Seoul have successfully integrated logistics into national strategic planning, characterized by Trencher as "Smart City 2.0" [6]-emerging cities often face "siloed governance" issues. As noted by Tan and Taeihagh (2020), this fragmentation impedes the effective integration of hard urban infrastructure with the necessary soft institutional capacity, resulting in unsustainable investments and disconnected public services [8]. Consequently, Yigitcanlar et al. emphasize that without addressing these core institutional, social, and environmental dimensions collectively, technological deployment alone cannot render a city truly "smart" [9].

To address this gap, this research employs a comparative multi-case study approach [10] to analyze the developmental trajectories of Singapore, Seoul, and Jakarta. By contrasting the highly integrated and participatory governance models of Singapore and Seoul with the transitional challenges observed in Jakarta, the study aims to identify the specific institutional frameworks and policy mechanisms required to build adaptive smart cities. The study further derives policy implications and practical recommendations for emerging economies like Vietnam, aiming to support the development of integrated smart city strategies. Furthermore, the study evaluates the current status of Vietnam's major urban centers against these six dimensions to derive tailored, actionable policy implications. Ultimately, this research contributes to the applied literature on integrated smart city governance, providing evidence-based insights to help policymakers and urban planners bridge the institutional gap in Vietnam.

2. LITERATURE REVIEW

The concept of smart city has attracted growing attention in academic research, policy discourse, and urban practice. Initially, definitions emphasized the application of information and communication technologies (ICT), sensors, and data analytics to manage urban operations. IBM conceptualizes a smart city as one that is instrumented, interconnected, and intelligent, emphasizing real-time data collection and system integration to enhance

operational efficiency [3]. Similarly, Cisco highlights the role of digital networks and connectivity in improving urban livability, workability, and sustainability [4]. The concept of smart city has evolved from a technocentric focus to a more holistic, citizen-centric approach.

To operationalize this holistic view, this study adopts the Quadruple Helix Model of innovation [11]. The Quadruple Helix model extends the traditional "Triple Helix" (University-Industry-Government) by integrating a fourth dimension: Civil Society (citizens and users). This framework posits that successful smart city development relies on the dynamic synergy among four key actors: government (public sector), industry (private sector), academia (universities/researchers), and civil society (citizens).

International organizations tend to adopt a more integrated and development-oriented view. The World Bank defines a smart city as one that leverages data, digital technologies, and innovation to improve urban service provision, resilience, and inclusive growth, particularly in rapidly urbanizing regions [12]. UN-Habitat further emphasizes intergenerational sustainability, defining smart cities as those that use ICT and innovation to enhance quality of life, urban efficiency, and competitiveness while meeting the needs of both present and future generations [5].

From a governance and policy perspective, the Organization for Economic Co-operation and Development (OECD) frames smart cities as places that use digitalization and data to improve citizen well-being, sustainability, and inclusive economic development, supported by effective governance structures and stakeholder collaboration [6]. This view underscores that technology alone is insufficient without institutional capacity, regulatory frameworks, and coordinated decision-making.

In the European policy context, smart cities are closely linked to environmental sustainability and climate objectives. The European Commission defines smart cities as those in which traditional urban networks and services are done more efficiently through digital solutions, contributing to reduced resource consumption, lower emissions, and enhanced quality of life for residents and businesses [13].

Academic literature has recently adopted a holistic and multidimensional approach for defining a smart city. One of the most influential frameworks is proposed by Giffinger et al. (2007), who define smart cities through six interrelated dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living [7]. This framework has been widely applied in empirical studies, benchmarking exercises, and comparative urban analyses.

More recently, scholars have increasingly emphasized a human-centric perspective, arguing that smart cities should prioritize social inclusion, citizen participation, and ethical use of data rather than focusing narrowly on technological sophistication [14], [15]. In this view, a city cannot be considered “smart” unless digital solutions meaningfully enhance citizens’ capabilities and access to public services.

The development of smart cities worldwide is underpinned by interrelated components that enable urban systems to become intelligent, efficient, sustainable, and citizen-centric. While different models and frameworks exist, the literature reveals a convergent structure comprising technological, human/social, institutional/governance, economic, environmental, and infrastructural dimensions [7], [16], [17]. These components provide a conceptual foundation for understanding smart city development globally and in Asia, comprising six dimensions.

Figure 1. Six dimensions of smart city (Source: Adapted from [7]).

Based on the provided literature, the development of smart cities globally has evolved through distinct phases, shifting from a focus on hardware and technology to a more holistic, human-centric, and institutional approach. A heavy reliance on technology characterized the initial stage of smart city development as the primary driver of urban change (Smart City 1.0 - The Techno-Centric Era)

Later frameworks emphasize three overarching systems: technological, human, and institutional [16], reflecting the socio-technical nature of smart cities, which can be grouped into six core domains: technological and digital infrastructure, human and social capital, governance and institutional systems, environmental sustainability and resilience, urban infrastructure, and service systems.

Globally, cities in Europe and North America have focused on interoperable platforms and data-driven decision-making, often supported by private technology providers [15]. In contrast, Asian smart city initiatives place strong emphasis on nationwide digital infrastructure, with governments actively investing in broadband networks, digital identity systems, and integrated city platforms. The Asian Development Bank notes that digital infrastructure is often cited as a prerequisite for broader smart-city transformations in developing Asian economies.

Human and social capital are essential parts of smart city development, as technology alone cannot deliver inclusive and sustainable urban outcomes. This dimension encompasses education, digital skills, creativity, social trust, and citizen participation, which enable residents to effectively adopt, use, and co-create smart city solutions [14], [15]. Contemporary smart city literature emphasizes a people-centered approach (civil society), highlighting the importance of digital inclusion, civic engagement, and capacity building to ensure that technological innovation enhances quality of life rather than deepens social inequalities [5]. In the Asian context, where demographic diversity and digital divides remain significant, strengthening human and social capital is particularly critical for achieving equitable and inclusive smart city development [18].

Governance and institutional systems are widely recognized as decisive factors in the success of smart city initiatives, as they determine how technologies are planned, regulated, and implemented in alignment with public objectives. This component encompasses policy frameworks, regulatory mechanisms, institutional capacity, and cross-sector coordination, ensuring that smart city development is transparent, accountable, and strategically guided [6], [18]. The literature emphasizes that effective smart city governance relies on multi-level governance and public-private partnerships, supported by data governance, ethical standards, and citizen trust. In the Asian context, smart city governance is often characterized by a state-led and top-down approach (the dominance of the government helix), where national governments play a central role in defining visions, mobilizing resources, and coordinating local implementation, as exemplified by regional initiatives such as the ASEAN Smart Cities Network [18].

Economic and innovation systems are core components of smart cities, as they link digital transformation to urban competitiveness and long-term growth. This dimension emphasizes the development of knowledge-based economies, innovation ecosystems, entrepreneurship, and digital business environments, supported by smart infrastructure and open data platforms [7], [15]. The literature highlights that smart cities foster innovation by enabling collaboration among firms, research institutions, and governments, thereby generating new services, business models, and productivity gains [19]. In the Asian context, smart city initiatives are closely aligned with national economic development and industrial upgrading strategies (the role of the industry helix), leveraging digital infrastructure and smart technologies to enhance economic resilience and regional competitiveness [20].

Environmental sustainability and urban resilience are central components of smart cities, reflecting the need to address climate change, resource scarcity, and increasing environmental risks in urban areas. This dimension focuses on integrating digital technologies into sustainable urban planning to improve energy efficiency, optimize resource management, reduce emissions, and strengthen cities' capacity to adapt to and recover from environmental shocks [7], [21]. Smart environmental systems-such as smart grids, environmental monitoring, and climate-responsive infrastructure-enable data-driven decision-making and long-term resilience planning. The literature highlights that, particularly in Asia, where cities are highly vulnerable to climate-related hazards, smart city strategies increasingly prioritize urban resilience and adaptation, alongside sustainability goals, as essential pillars of future urban development [5], [20].

Urban infrastructure and service systems constitute the operational core of smart cities, in which digital technologies are embedded in physical infrastructure to improve the efficiency, reliability, and accessibility of urban services. This component includes smart transportation, intelligent energy and water systems, digital healthcare, and smart buildings, enabled through ICT, IoT, and data-driven management platforms [18, 25]. The literature emphasizes that integrating digital solutions into urban infrastructure enhances service quality, reduces operational costs, and supports sustainable urban growth. In the Asian context, where rapid urbanization and infrastructure pressures are acute, smart infrastructure and service systems are increasingly prioritized to address congestion, service demand, and infrastructure resilience as part of broader smart city development strategies [14, 19].

In contrast to Western discourses that prioritize soft infrastructure and social inclusion, Asian smart city trajectories are shaped by the developmental state model and the pressures of rapid urbanization. Yigitcanlar et al. (2018) characterize this as a techno-centric approach, in

which smart mobility and smart environments are prioritized to mitigate immediate urban externalities such as congestion [9]. This aligns with Trencher's (2019) classification of Smart City 2.0-a government-led paradigm, exemplified by Seoul and Singapore through the strategic integration of logistics and mobility to improve efficiency [22], [23]. Conversely, in developing Southeast Asia, Tan and Taeihagh (2020) argue that 'siloed governance' creates a critical disconnect: while physical infrastructure expands, the institutional capacity requisite for effective urban logistics integration remains deficient [8]. Consequently, smart city frameworks must be conceptualized not as fixed models, but as adaptive systems responsive to these specific institutional and socio-economic imperatives.

3. RESEARCH METHODOLOGY AND FINDINGS

3.1. Research Methodology

Given the complex, context-dependent nature of urban development, this paper employs a qualitative research design utilizing a comparative multiple-case study approach [10]. This methodological choice is predicated on the necessity to explore "how" and "why" specific smart city governance models succeed or fail in different institutional settings, moving beyond the limitations of purely quantitative metrics. The research follows a replication logic, where each case serves as a distinct experiment to confirm or differentiate the theoretical propositions regarding the transition from techno-driven to human-centric smart city models. The analytical framework is grounded in the six multidimensional components of smart cities-smart economy, people, governance, mobility, environment, and living [7]-which provides a standardized taxonomy for evaluating urban performance.

A purposive sampling strategy was employed to select three distinct Asian cities-Seoul, Jakarta, and Singapore-based on their typological relevance to the research objectives and the Vietnamese context. Seoul was selected as the primary benchmark representing the "Smart City 2.0" paradigm, characterized by a government-led, integrated approach that successfully synchronizes logistics with national strategic planning. Seoul illustrates the effective deployment of ubiquitous sensor networks and public-private data partnerships. Singapore is widely recognized as one of the world's leading smart cities, driven by its national Smart Nation vision launched in 2014 and refreshed in 2024 under Smart Nation 2.0: A Thriving Digital Future for All. Conversely, Jakarta was selected as a "contextual peer" to Vietnam; as a developing Southeast Asian megacity, it shares similar characteristics of infrastructure gaps and transitional governance, providing a realistic reference for emerging economies.

To ensure the results are valid and reliable, the study employs data triangulation by synthesizing secondary data from three authoritative tiers. First, government policy documents and master plans (such as Smart Nation Singapore and "100 Smart Cities Movement" in Indonesia) were analyzed to understand the official strategic vision. Second, quantitative indicators and qualitative assessments were sourced from international organizations, specifically the WB and the ADB, which provide critical data on digital infrastructure as a prerequisite for smart city transformation in developing Asian economies. Finally, academic literature and specialized industry reports were reviewed to cross-verify policy claims against operational realities [2], [6], [20]. The gathered data were subjected to a cross-case synthesis, mapping each city's smart development against the theoretical framework of the Quadruple Helix [11] and the six smart city dimensions [7].

The scoring process followed a rigorous three-step protocol:

(1) Content Coding: Data collected for each city were coded into Giffinger's six smart city dimensions (Economy, People, Governance, Mobility, Environment, Living);

(2) Expert Assessment: A purposively selected panel of 12 experts evaluated the coded data. The panel comprised six academic researchers specializing in urban planning and six senior municipal policymakers with over 10 years of experience in smart city projects. To ensure standardized evaluation, the experts independently assessed each dimension using a scoring rubric on a 5-point integer Likert scale (ranging from 1 = Nascent/Ad-hoc to 5 = Optimized/Integrated). The scoring rubric was developed as shown in Table 1.

Table 1. The scoring rubric for expert assessment.

Score	Development Level	Definition & Criteria
5	Optimized Integrated	System-Integrated: Fully interoperable systems; governance is proactive and predictive; high citizen co-creation. (e.g., Singapore's Governance)
4	Managed/Data-Driven	Data-Driven: Infrastructure is digitized and interconnected; widely used open data; minor gaps in cross-sector integration. (e.g., Seoul's Mobility)
3	Functional/Siloed	Project-Based: Key smart initiatives exist but operate in silos; there is a lack of region-wide integration and reactive governance. (e.g., Jakarta)
2	Emerging / Pilot	Initial Stage: Strategy defined, but implementation is limited to pilots; infrastructure gaps constrain scaling. (e.g., Hanoi's Environment)
1	Nascent Ad-hoc	No coherent strategy; minimal digital infrastructure or service provision.

(3) Consensus Building: Following the independent scoring phase, a modified Delphi method was employed to ensure inter-rater reliability. In instances where individual scores diverged significantly, the expert panel engaged in structured discussions to reach a qualitative consensus on the appropriate integer values. Finally, the aggregate scores presented in the Results section were calculated as the arithmetic mean of the final integer scores from the 12 experts. The calculation follows this formula:

$$S_d = \frac{\sum_{i=1}^{N} x^i}{N}$$

Where:

- S_d represents the final aggregate score for a specific dimension of a city, n is the total number of experts.
- x_i is the final consensus integer score assigned by expert i
- N represents the total number of experts in the panel (N = 12).

3.2. Research Findings

3.2.1. Case Studies Analysis

Singapore (The Integrated Model)

Singapore's smart economy is underpinned by the strategic integration of digital transformation into national economic planning. According to the Singapore Digital Economy Report, the digital economy accounted for around 17.7% of GDP in 2023 [21], reflecting a growth rate significantly higher than that of the overall economy. This performance positions Singapore among the most digitally intensive economies in Asia. For smart people, Singapore

emphasized human capital development, digital inclusion, and social cohesion. By 2022, 99% of resident households had internet access, indicating near-universal digital connectivity [24]. The SG Digital Office has trained hundreds of thousands of older residents in basic digital skills and supported low-income households with subsidized broadband access and devices. Workforce development is further supported by the national SkillsFuture program, which integrates digital competencies across all stages of career development.

For smart governance, approximately 99% of public services in Singapore are available online through the national digital identity platform Singpass, enabling seamless access across government agencies and an increasing number of private-sector services [25]. Singapore has maintained public trust in digital government by establishing a comprehensive legal and regulatory framework to support data protection and cybersecurity, including the Personal Data Protection Act and the Cybersecurity Act [24]. The Model AI Governance Framework and the AI Verify Toolkit operationalize ethical principles into practical mechanisms for testing and certifying AI systems.

Table 2. Six-dimensional assessment of Singapore's smart city performance.

Dimensions	Key Strengths	Challenges/Constraints
Smart Economy	High digital GDP share; strong AI strategy; SME digital adoption	Energy-intensive data centers; global talent competition
Smart People	Near-universal internet access; strong digital inclusion programs	Online harms; social isolation risks
Smart Governance	Advanced e-government; global AI governance leadership	Algorithmic transparency; cross-border data governance
Smart Mobility	World-class digital connectivity; integrated urban platforms	Cyber resilience; infrastructure sustainability
Smart Environment	AI-enabled urban greenery; smart energy management	Carbon neutrality; climate adaptation costs
Smart Living	Digital health and safety systems; smart housing	Aging population; digital wellbeing

For smart mobility, Singapore has achieved near-universal 5G standalone coverage and operates the Next Generation Nationwide Broadband Network, which supports high-speed connectivity for public services and private innovation. In the transport sector, real-time traffic management, predictive maintenance systems for rail and bus networks, and integrated public transport information platforms enhance operational efficiency and user experience. These systems are embedded within broader urban development projects, such as the Punggol Digital District, where an Open Digital Platform integrates energy, transport, and building management systems [20].

For a smart environment, environmental sustainability and resilience are core components of Singapore's smart city strategy, aligned with the national vision of a "City in Nature". The city deploys AI and digital twin systems to monitor urban greenery and manage environmental risks, while smart energy and building platforms optimize resource use based on real-time data. These initiatives enhance environmental governance and urban resilience, although long-term challenges remain in achieving carbon neutrality and mitigating the environmental impact of expanding digital infrastructure [5], [18].

Singapore's smart living initiatives apply digital technologies to enhance the quality of life through smart housing, digital health, and community safety systems. Sensor-based monitoring improves the reliability of public housing infrastructure, while platforms such as myResponder engage citizens as first responders to strengthen emergency response and community resilience. Digital ecosystems for aging populations support independent living and continuous social and medical connectivity, reflecting a human-centered approach that aligns technological innovation with everyday well-being [24], [25].

Jakarta, Indonesia (The Emerging Context)

Indonesia has experienced rapid urbanization over the past two decades, resulting in increasing pressures on urban infrastructure, environmental quality, and public service delivery. In response, the national government launched the "100 Smart Cities Movement" as a strategic framework to integrate information and communication technologies (ICTs) into urban management and development planning [26].

For a smart economy, Jakarta's smart economy initiatives primarily focus on digitizing public services and supporting micro, small, and medium-sized enterprises (UMKM) through online licensing, e-payments, and digital marketplaces. These measures have reduced transaction costs and improved regulatory compliance. However, the city's innovation ecosystem remains weakly connected to universities, research institutions, and venture capital networks, limiting the generation of high-value digital industries and global competitiveness [27].

For smart people, citizen engagement platforms such as JAKI and Qlue have strengthened communication between residents and municipal authorities. Nevertheless, empirical studies indicate that participation remains largely reactive rather than deliberative, with limited opportunities for citizens to influence policy design. Digital skills gaps continue to exclude vulnerable populations from fully benefiting from smart city services [8], [18].

For smart governance, Jakarta has developed one of Indonesia's most advanced e-government systems, supported by open data initiatives and centralized monitoring centers. Despite this, governance capacity is constrained by siloed institutional structures and inconsistent data-sharing standards. Legal frameworks for data protection and algorithmic accountability remain underdeveloped at the municipal level [27].

For smart mobility, the expansion of MRT, LRT, and BRT systems reflects strong investment in intelligent transport infrastructure. Real-time traffic monitoring and route-planning applications have improved commuter information. However, chronic congestion persists due to urban sprawl, fragmented metropolitan governance, and limited interoperability between transport data systems [27], [28].

For a smart environment, Jakarta focuses on disaster risk management, particularly flood monitoring and air quality reporting. While these tools enhance short-term responsiveness, long-term climate resilience planning is hindered by the lack of integrated environmental data platforms and predictive modeling capacities [29].

For smart living, digital platforms have expanded access to public health information, housing services, and emergency response systems. Yet, social impact assessments remain limited, and quality-of-life improvements are uneven across socio-economic groups and urban districts [27], [29].

Table 3. Six-dimensional assessment of Jakarta's smart city performance.

Dimensions	Key Strengths	Challenges/Constraints
Smart Economy	Expanding digital market access; improved business-government interaction; growth of urban digital services.	Limited integration with R&D ecosystems; weak innovation clustering; dependency on public platforms rather than private-sector innovation
Smart People	Improved communication channels; increased transparency in service requests	Digital divide among low-income and elderly populations; limited co-creation in policy design
Smart Governance	Enhanced data-driven decision-making; improved administrative efficiency	Fragmented inter-agency coordination; legal and regulatory gaps in data privacy and AI governance
Smart Mobility	Advanced public transport infrastructure; improved traffic information systems	Persistent congestion; limited data integration across transport modes; weak metropolitan-scale planning
Smart Environment	Rapid response to environmental risks; improved public awareness	Fragmented environmental data systems; limited predictive analytics for climate adaptation
Smart Living	Enhanced access to urban services; stronger community-based safety systems	Uneven quality-of-life outcomes across districts; limited measurement of social impact

Seoul, Korea (The Tech-Participatory Model)

Seoul is widely recognized as a global leader in smart city development, supported by a long-term strategy that integrates digital transformation, sustainable development, and social welfare. The Seoul Metropolitan Government (SMG) has promulgated the Smart City & Digitization Master Plan 2021-2025, which conceptualizes smart cities not merely as technology-driven systems, but as people-centered urban ecosystems grounded in open data, innovation, and transparent governance [2], [18].

For a smart economy, Seoul has developed a robust innovation ecosystem that connects government agencies, technology firms, universities, and research and development centers. Open data and digital platforms enable enterprises to create value-added services in areas such as transportation, environmental monitoring, and digital commerce. However, high operational costs and global competition for skilled labor pose constraints, particularly for small firms and startups [30].

For smart people, Seoul's smart city policy places strong emphasis on digital inclusion, supported by training programs for elderly citizens, persons with disabilities, and low-income groups. The introduction of a public-sector metaverse platform has expanded channels for civic participation and access to administrative services. Nevertheless, disparities in digital skills and access persist, especially among the aging population [8].

For smart governance, Seoul is frequently cited as a benchmark for institutionalized smart city governance. The Master Plan, supported by a Smart City Council and an extensive open data portal, enhances transparency and evidence-based policymaking. Despite these strengths, the complexity of coordinating across multiple agencies and administrative levels remains a significant challenge.

For smart mobility, Seoul's public transportation system integrates real-time data to optimize service delivery and commuter information. The city is also a pioneer in testing autonomous vehicles and Urban Air Mobility solutions. However, achieving seamless integration of data and planning across the broader metropolitan region remains a work in progress [18], [20].

For a smart environment, Seoul has environmental sustainability initiatives, including RFID-enabled waste management systems that have significantly reduced food waste and increased recycling rates. The city has also implemented energy monitoring platforms and carbon-neutral strategies. Nonetheless, expanding renewable energy infrastructure at the scale of a megacity remains constrained by spatial, financial, and technical factors [29].

For smart living, digital platforms for healthcare, public safety, and social welfare services have improved accessibility and everyday quality of life for residents. However, comprehensive and standardized methods for measuring the social and equity impacts of these initiatives are still under development.

Table 4. Six-dimensional assessment of Seoul's smart city performance.

Dimensions	Key Strengths	Challenges/Constraints
Smart Economy	Strong innovation infrastructure, global investment attraction, talent magnet	High cost of living and technology deployment, intense competition for skilled labor
Smart People	High digital literacy, strong focus on vulnerable groups	Persistent digital divide among elderly populations
Smart Governance	Institutionalized governance, transparency, and data-driven decision-making	Complex inter-agency coordination, high administrative costs
Smart Mobility	Highly efficient public transport, advanced mobility innovation	Incomplete integration across the wider metropolitan region
Smart Environment	Significant waste reduction, strong community engagement in energy transition	Challenges in scaling renewable energy at the megacity scale
Smart Living	Improved access to public services, enhanced quality of life	Limited quantitative measurement of social impact and equity outcomes

The comparative analysis of Seoul, Singapore, and Jakarta highlights three distinct development trajectories in smart city transformation, shaped by differences in governance capacity, economic structure, technological maturity, and socio-political contexts. Across all three cases, the six smart city dimensions-smart economy, smart people, smart governance, smart mobility, smart environment, and smart living-are interdependent. Together, these cases illustrate that smart city success is not driven by technology alone, but by the alignment of institutional frameworks, citizen engagement, innovation ecosystems, and long-term urban planning strategies.

Seoul represents a data-driven and citizen-centric model, characterized by strong public-sector leadership, open data platforms, and participatory governance mechanisms that integrate technology into everyday urban management. Singapore exemplifies a state-orchestrated, systems-integrated model in which national digital strategies, regulatory coherence, and strong public-private partnerships enable holistic, scalable, and sustainable smart city solutions. In contrast, Jakarta reflects a context-adaptive and problem-oriented

model, focusing on digital tools to address immediate urban challenges such as congestion, flooding, and service accessibility within a more fragmented institutional environment. Table 5 summarizes a comparative assessment of smart city development across six dimensions.

The three case studies demonstrate that there is no universal blueprint for smart city development. Instead, successful models are shaped by local institutional capacities, socio-economic conditions, and long-term policy commitments. For emerging economies like Vietnam, the strategic pathway lies in combining Singapore's systems integration, Seoul's citizen-centric governance, and Jakarta's problem-driven innovation into a hybrid model tailored to national development priorities. Such an approach can support the creation of smart cities that are not only technologically advanced but also inclusive, resilient, and sustainable.

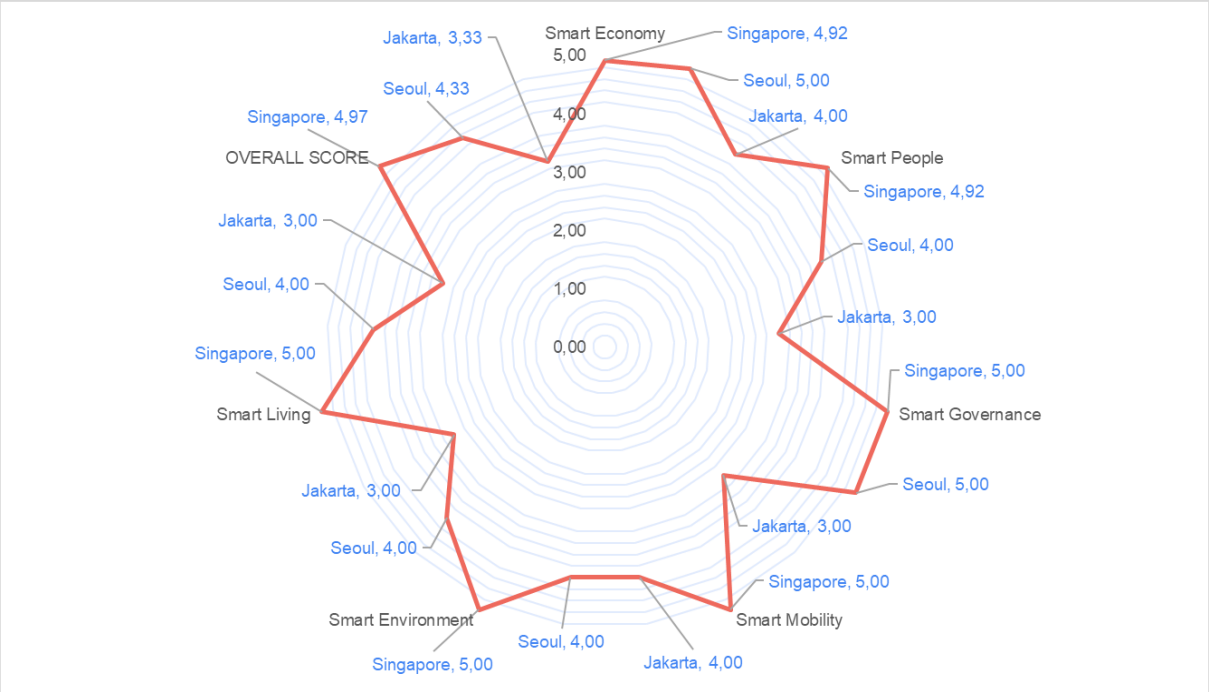

Figure 2. Comparative assessment of smart city development across six dimensions of 3 cities.

3.2.2. Current Status of Smart City Development in emerging economies - The case of Vietnam

The development of smart cities in emerging Asian economies is rapidly evolving as a strategic response to unprecedented urbanization. With projections indicating that over 65% of Asia's population will live in urban areas by 2050, cities are leveraging digital transformation to mitigate severe pressures on transportation, public services, and the environment [31], [32].

Rapid urbanization in Vietnam's two largest cities-Hanoi and Ho Chi Minh City (HCMC)-presents both opportunities and challenges for sustainable urban development. Using a six-dimensional smart city framework (smart economy, smart people, smart governance, smart mobility, smart environment, and smart living), this study analyzes the current state of urbanization and digital transformation in both cities. Comparisons are drawn with leading cities Seoul, Singapore, and Jakarta to highlight relative strengths and structural gaps as well as policy implications for Vietnam.

Vietnam's urbanization rate reached approximately 45% in 2025, placing it at the regional level in Asia, with urban areas contributing about 70% of the national GDP [32]. Both Hanoi and HCMC have been included in global smart city rankings-with Hanoi ranking 88th and HCMC 101st in the 2025 IMD Smart City Index-and in broader indices such as CIMI 2025 (HCMC ranked 132/183), indicating room for improvement in the planning, environment, and governance dimensions [33]. Hanoi, with a population of 8.5 million, has committed to becoming a smart, modern, green capital by 2025-2030, as outlined in city policies aligned with national digital transformation goals. Ho Chi Minh City, with a population of 10 million and growing, with integration aims to become a regional innovation hub by 2050, pursuing high-density, transit-oriented, and data-driven urban planning. Rapid urban growth is exerting pressure on transport, housing, services, environment, and governance systems in both cities [33]-[35]

The city has a roadmap for smart city development in three phases through 2030, focusing on building a centralized monitoring and operations center and integrating telecommunications infrastructure, IoT, and big data systems to support timely and accurate decision-making. Hanoi is developing traffic, security, and communication monitoring centers, as well as IT support centers, while also applying GIS to urban planning and management. Urbanization has expanded service sectors and ICT adoption, but innovation ecosystems remain nascent [36].

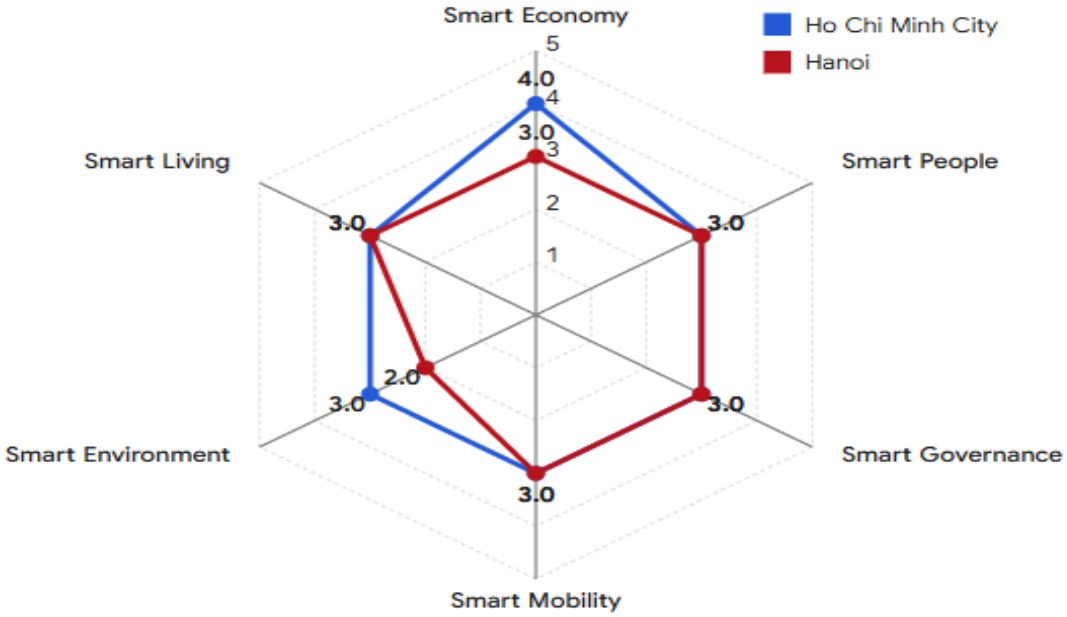

Figure 3. Multi-dimensional Maturity Profile of Smart City Development in Hanoi and Ho Chi Minh City.

Ho Chi Minh City has developed a smart city project for the 2017-2025 period with four main pillars: a shared data repository, an intelligent operations center (IOC), an economic and social forecasting simulation center, and a cybersecurity center. The city is accelerating digital transformation across all sectors, building an open data ecosystem, and applying IoT and AI in the management of traffic, security, healthcare, and public services. Telecommunication infrastructure, such as 5G and fiber-optic networks, is being widely deployed to lay the foundation for smart solutions [37], [38].

Both cities improve digital literacy and access to services, but disparities persist across socio-economic groups (e.g., vulnerable populations and aging residents). Vietnam's public-sector workforce still faces gaps in digital governance capacity. Smart city initiatives in Hanoi are integrated into city planning (e.g., Resolution 18-NQ/TU), aiming to drive digital transformation across services. Directive 17-CT/TU promotes innovation and digital governance in HCM, but challenges remain in integrating governance and coordinating digital projects across agencies [38].

To advance smart mobility and combat chronic congestion, both cities are investing heavily in hard infrastructure, including the expansion of metro lines, urban rail, and bus systems. These cities have also deployed digital traffic management tools, such as AI-enabled traffic cameras. Despite these efforts, urbanization outstrips transport demand, leading to congestion and indicating that mobility systems still lag behind smart city ambitions [37], [39].

Smart city efforts include environmental monitoring and pollution management tools; however, environmental scores on global indices remain relatively low, reflecting ongoing air and water quality challenges and urban sprawl [12], [31]. In Hanoi and HCM City, quality-of-life improvements through digital health and e-services are progressing, enhancing urban residents' well-being. Yet, these initiatives lack robust frameworks to quantitatively evaluate their social impact and equity. Ensuring that smart living technologies tangibly benefit all urban districts, rather than just affluent areas, remains an unresolved challenge [34], [37].

To synthesize this analysis and provide a direct comparative baseline against the Asian case studies (Singapore, Seoul, Jakarta), Table 7 details the specific strengths and constraints of Vietnam's two primary economic hubs.

Table 5. Six-dimensional assessment of Smart City Development in emerging economies (The case of Hanoi and Ho Chi Minh City).

Dimensions	Key Strengths	Challenges / Constraints
Smart Economy	Rapid expansion of digital services and ICT adoption; robust 5G and telecommunications infrastructure deployment.	Nascent innovation ecosystems; limited R&D clustering; heavy reliance on basic digital services rather than high-value tech generation.
Smart People	Increasing overall digital literacy; growing integration of digital tools in daily urban life.	Persistent digital divide affecting elderly and vulnerable populations; public sector workforce lacks advanced digital governance capacity.
Smart Governance	Strategic political commitment (e.g., Resolution 18-NQ/TU, Directive 17-CT/TU); establishment of IOCs and shared data repositories.	Siloed administrative operations; fragmented inter-agency coordination; challenges in executing integrated, cross-sector digital projects.
Smart Mobility	Ongoing expansion of metro and urban rail networks; deployment of AI cameras and digital traffic monitoring centers.	Urbanization outpaces infrastructure growth, leading to chronic congestion and limited interoperability between different transport modes.

Dimensions	Key Strengths	Challenges / Constraints
Smart Environment	Initial implementation of GIS in urban planning and deployment of pollution monitoring tools.	Low global environmental scores; inadequate management of urban sprawl; lack of predictive analytics for climate and flood resilience.
Smart Living	Steady progression in digital health, e-government platforms, and digital public service accessibility.	Uneven quality-of-life improvements across districts; underdeveloped frameworks for evaluating social equity and long-term impact.

3.2. Discussions and Lessons Learned

To move beyond fragmented development, emerging economies in Asia must close the "institutional gap". Successful transformation requires shifting from isolated technological procurement to establishing robust data governance laws, fostering public-private partnerships, and prioritizing digital literacy to ensure sustainable and inclusive urban growth.

The analysis reveals that Singapore's smart city development is characterized by strong institutional coordination, high levels of digital inclusion, and the strategic integration of technology with national development goals. From a regional perspective, Singapore offers a transferable reference model for Vietnam seeking to align smart city initiatives with economic competitiveness and social inclusion. However, the city-state's centralized governance structure and high fiscal capacity may limit the direct replicability of its model in more decentralized or resource-constrained contexts.

The case of Seoul demonstrates that successful smart city development depends not solely on the scale of technological deployment but on the strength of institutions, data governance, and meaningful citizen participation. For Vietnam, adapting Seoul's model requires contextualization to local institutional capacities and resource constraints, with a strategic emphasis on legal foundations, digital human capital, and inclusive, sustainability-oriented urban governance.

The case of Jarkta offers several transferable lessons for Vietnam. First, smart city development should be embedded within a nationally coordinated sustainability framework, rather than pursued as isolated technological projects. Second, building local institutional capacity and digital governance skills is essential for long-term system maintenance and innovation. Third, inclusive stakeholder engagement, particularly through PPPs and community participation, can enhance social legitimacy and financial viability. Finally, adopting a comprehensive evaluation framework linked to the SDGs can help Vietnamese cities measure not only technological progress, but also social and environmental impacts.

Based on these findings, the paper proposes a conceptual transfer model for emerging economies, such as Vietnam, that emphasizes institutional coherence, citizen-centered digital strategies, and sustainability-driven smart-city governance.

Some solutions and implications are proposed for Vietnam to strengthen innovation clusters that link universities, enterprises, and local governments, and to improve regulatory incentives for startups and R&D. Vietnam should prioritize nationwide digital literacy programs and inclusive access to smart services, especially for vulnerable and aging populations. Vietnam needs a unified legal and institutional framework for data governance, interoperability, and public-private collaboration. Vietnam should align smart transport investments with transit-oriented development and national digital infrastructure strategies.

Vietnam should embed smart environmental monitoring into urban planning and climate adaptation strategies. Vietnam should also develop integrated digital public service platforms with standardized performance indicators.

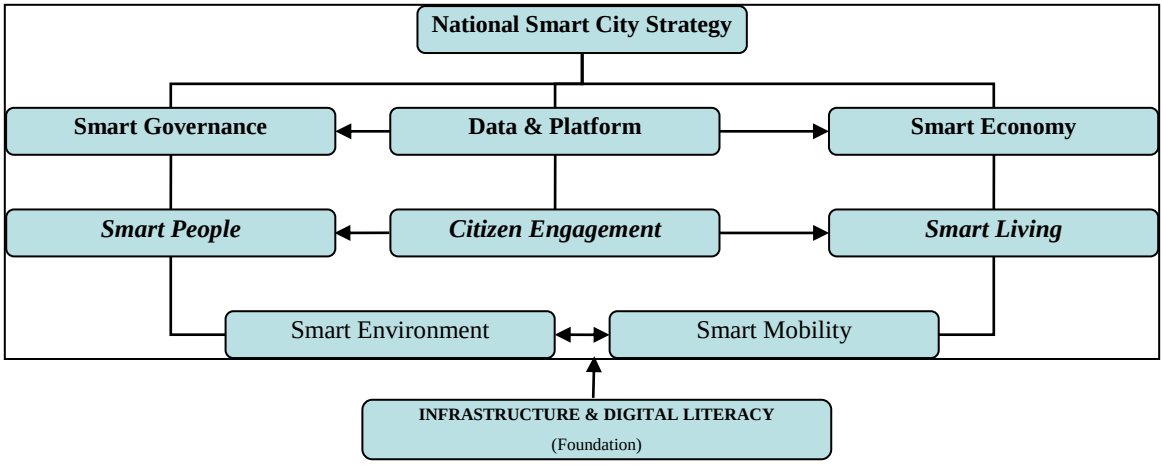

Figure 4. Transfer Model for Vietnam's Smart City Development.

4. CONCLUSION

This study examined smart city development in Asian emerging economies through comparative case studies, with particular reference to Singapore, Seoul, and Jakarta. The findings demonstrate that while digital technologies are important enablers, effective smart city development depends primarily on governance capacity, institutional coordination, and policy coherence rather than technological advancement alone.

Cities with strong and stable governance structures are better able to integrate digital technologies-especially in transport and urban services-into coherent and scalable systems. In contrast, fragmented and project-based implementation approaches tend to result in limited integration and uneven outcomes. These patterns underscore the critical role of institutional readiness in shaping smart city performance in emerging-market contexts.

Based on the comparative analysis, the study highlights important policy implications for emerging economies, specifically Vietnam. Smart city initiatives should prioritize institutional strengthening, cross-sector collaboration, and aligning digital infrastructure investments with long-term urban governance and development objectives, rather than focusing solely on technology-driven solutions. Hanoi and Ho Chi Minh City are advancing along Vietnam's smart city trajectory, with solid progress in digitalization and urban infrastructure. However, gaps remain in governance integration, smart mobility, environmental resilience, and inclusive implementation when benchmarked against cities like Singapore, Seoul, and Jakarta. Strategic reforms in planning, institutional frameworks, and citizen-centric policies can accelerate Vietnam's transition to sustainable, inclusive smart cities.

This study acknowledges certain limitations. The reliance on secondary data (e.g., WB and ADB reports) and a limited sample of three international cases may limit the generalizability of the findings across the entire Asian continent. Future research should incorporate primary data collection, such as field surveys and in-depth interviews, to validate these comparative indices.

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