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Stabilizing the Economy in Citizen-Centric Smart Cities

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Abstract

The development of smart cities has often been plagued by a technological advancement without the corresponding human-centered needs of residents. While many initiatives have prioritized innovation over inclusion, successful examples such as Curitiba, Brazil demonstrate that citizen engagement, long-term planning, and social inclusion are critical to sustainability. This paper examines the evolution of smart city frameworks through a citizen-centric lens, integrating insights from the evolving Maslow's Hierarchy of Needs to highlight the growing importance of digital access, cybersecurity, and economic stability as fundamental human needs. But also begin to introduce the concept of smart cities being forever evolving "beings" or regenerative infrastructure. Building upon the Natural Ecosystem™ framework, developed under the Peace Engineering concept, the paper explores how aligning investment, governance, and technology adoption fosters sustainable urban growth. Central to this discussion is the role of parallel markets, leveraging asset-backed stablecoins, in promoting monetary stability and social resilience within smart city ecosystems. The analysis draws on international case studies, including Curitiba, Singapore, and Seoul, to illustrate how transparent, well-regulated digital economies can enhance trust, inclusivity, and financial adaptability. Ultimately, the paper presents that the success of citizen-centric smart cities depends on integrating technological innovation with social equity and economic design, ensuring that digital transformation serves as an enabler of human and urban development rather than an end in itself.

Introduction

Over the past few decades, implementing smart cities has repeatedly faced the challenge of balancing technological potential with human needs. Many projects have failed by choosing modular and fragmented solutions over integrated platforms, prioritizing technological innovation rather than the well-being and participation of residents, resulting in limited impact and poor sustainability.

In contrast, successful initiatives like Curitiba (Brazil), recognized as the Smartest City in the World in 2023, highlight that the key difference lies in effective citizen engagement, promoting social inclusion, and implementing gradual strategies based on long-term planning.

The current challenge for citizen-focused smart cities extends beyond developing strategies; it requires consistent execution, considering that the core of citizen-centered initiatives can be understood through Maslow's Hierarchy of Needs. From this viewpoint, digitalization and technology are seen as vital components of modern urban life. However, adopting technology alone doesn't guarantee city development; it's crucial to foster economic stability by building resilient and inclusive financial ecosystems. This article aims to explore how economic stabilization interacts with the success of Citizen-Centric Smart Cities, focusing on how parallel markets based on asset-backed blockchain solutions, like stablecoins, can support economic and social sustainability in smart cities, communities, and complexes.

Smart City Projects – a Brief Analysis

According to Cisco Systems, one of the leaders in Smart City development, smart cities are designed for "improving citizen life through the strategic application of technology, focusing on connectivity, data, and security to create more efficient, sustainable, and responsive urban environments." Their vision was shaped by four key drivers:

1. Citizen-Centric Needs
2. Connectivity and Data
3. Security
4. Scalability and Interoperability

The primary focus was improving the quality of life for citizens by creating better services, new opportunities, and enhanced safety. While they emphasized creating a connected "nervous system" using IoT sensors and other inputs to generate real-time data that informs decision-making, they also wanted to ensure robust security for connected devices with data was critical for building trust and enabling the reliable use of smart city technologies. Finally, smart city solutions would be able to grow and work together seamlessly across different systems to meet evolving needs and foster sustainable digital transformation.

However, this vision faltered. Cisco discontinued its flagship platform Kinetic for Cities in 2021, as cities preferred modular solutions over centralized platforms. This highlighted a recurring challenge: many smart city initiatives emphasized technology first and citizen needs second, leading to marginal impact.

Lessons from Failures

A majority of the cause of failure can be categorized in one of the five categories. These are: market-reality mismatch, tech-first/needs-second priorities, vendor lock-in, weak governance, and top-down approaches all led to failed smart city projects.

Examples: Songdo (South Korea) – technologically advanced but underpopulated; Masdar City (UAE) – ambitious sustainability goals but fell short in practice.

Success Stories

Curitiba, Brazil – Named Most Intelligent City in the World (2023) due to its innovation ecosystem, public health platforms, housing projects, renewable energy adoption, and strong data governance.

In 2017 the creation of Pinhão Valley Innovation Ecosystem became the game-changer for the region. Startups, universities, non-profit and other institutions were set to create an integrated tech ecosystem.

Curitiba's approach has a "…central focus on enhancing the quality of life for citizens." Their mantra is that "innovation is only valid when it becomes a social process…"

Central to the approach is public health. In 2017 the city created an App that let you book appointments, get vaccinated, etc., called Health Now. This was the precursor to the Curitiba App, which now has 600 services and growing.

Infrastructure is also a big part of the Smart City initiatives. Building road bypasses, finishing the BRT (Bus Rapid Transit) corridor, called the Green Line, starting electrification of the bus fleet, and investing in several solar energy plants in many public buildings are tenant to citizen-centric services.

The Caximba New Neighborhood is an irregular housing complex of nearly 1,700 families next to two important rivers. There are new houses, regeneration of vegetation, and creating parks to protect the rivers. It is one of the largest housing projects in the history of Curitiba, that costs more that 50 million euros, which is financed by the French Development Agency. This is an example of how Smart City development must include outside capital.

Smart cities invariably rely on data flow. The way to that Curitiba manages data security is through e-cidadão, an e-citizen program. This initiative allows users to access various services with a single account instead of having to provide their data multiple times. It has security mechanisms, such as encryption and authentication, and complies with the General Data Protection Law (LGPD), a Brazilian law inspired by the European Union's GDPR. The LGPD establishes principles, rights, and duties for the processing of personal data. More than 73% of the 1.7 million people are actively registered on e-cidadão because of a well-designed and executed education campaign that informed the public about its benefits.

Curitiba has the most extensive per capita use of 5G of any city in Brazil. By streamlining legal and regulatory processes to speed the implementation and deployment of a more modern mobile and internet infrastructure, the city saw benefits in leaps and bounds.

Curitiba also provides free public Wi-Fi anywhere in the city. The city already has 310 access points with Wi-Fi Curitiba free connections. Currently, there are 307,000 users registered to use the service, with 80,000 new users in 2023 alone.

The city's transformation started in the early 1990s with The Lighthouses of Knowledge – a decentralized network of libraries that came online with the first Brazilian public internet connection in 1993 – revolutionized public education in Curitiba. It offered students and the community free access to computers and the internet. That was the beginning of the digital transformation. More than 20 years later, with the Pinhão Valley, these spaces are being reformulated and revitalized as the Lighthouses of Knowledge and Innovation. They provide "maker spaces" for students and teachers from municipal public schools, giving them access to skills and techniques such as 3D printing. They are open to the entire community.

Examples: Seoul, South Korea – Smart Seoul platform for real-time data, disaster management, and free Wi-Fi; Singapore – Nationwide sensors, smart traffic management, and Virtual Singapore digital twin for planning and sustainability.

These highlight the importance of citizen engagement, inclusivity, and long-term planning with a phased approach to deployment. Building on these success stories, it becomes clear that the sustainable transformation of urban environments relies on a holistic framework – one that not only integrates innovative technologies and infrastructure but also recognizes the complex web of social, economic, and policy interdependencies. Transitioning from the practical achievements seen in cities like Curitiba, the following section introduces the Natural Ecosystem™ Framework, which provides a comprehensive blueprint for nurturing resilient, citizen-centered smart cities through deliberate investment, collaborative policy-making, and adaptive technology adoption.

The Natural Ecosystem™ Framework

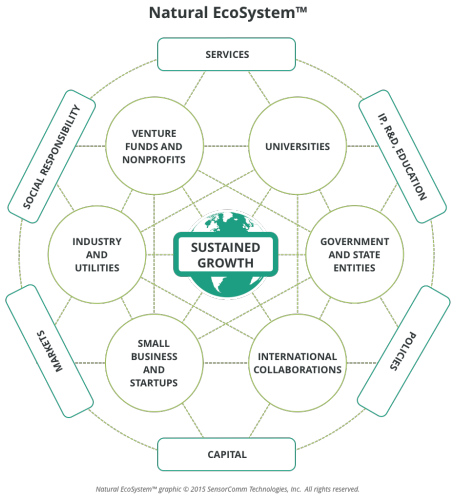

Figure 1. Natural Ecosystem™ formulation for sustained growth.

The Natural Ecosystem™ model was developed by SensorComm Technologies around 2016 as part of a Peace Engineering initiative that help shape the blueprint for sustained growth in smart cities. It emphasized interdependencies between investment, policies, and technology adoption which was reflected in Curitiba's success.

The Natural Ecosystem™ focuses on sustained growth of the community, as a whole, that is built on citizen-centric services. Through the successes in Brazil, the ability to visualize how the various interdependencies were implemented is apparent – everything for foreign direct investment to policies that reduce friction of implementation of technology (e.g. 5G).

Although each city will have its own requirements, the goal is to identify the key needs that will lead to the success of the smart city and create a phased approach in existing cities or a build-out in greenfield projects.

Citizen-centric frameworks mapped against Maslow's Hierarchy of Needs show that digital access, cybersecurity, digital belonging, online esteem, digital self-actualization, and self-transcendence have become central. Technology is a need, but without alignment to social and economic priorities, it cannot deliver maximum value

As we shift from the conceptual base of the Natural Ecosystem™ Framework to a deeper look at citizen-focused strategies, it is important to consider how changing human needs relate to technological progress and urban growth. Understanding this interaction helps city planners and policymakers create solutions that genuinely address the priorities of the communities. By viewing these changes through the lens of Maslow's Hierarchy of Needs, we gain a useful perspective on the evolving expectations and needs that define modern urban life. As additional cities are brought online, the Natural Ecosystem™ actually become nodes of a larger distributed framework.

Maslow's Hierarchy as Citizen-Centric Criteria

The focus of citizen-centric smart cities has been missing execution of a well-intended strategy. The core of any citizen-centric effort can be formulated based on Maslow's Hierarchy of Needs. Looking at the evolution of the actual categories of needs can provide the insight necessary to lock-in on value and identify key roll-out strategies. Zhang et. al uses Maslow's Hierarchy of Needs to quantitatively rank smart cities in China. However, the evolution of Maslow's Needs shows that even in the 5-year period since the publication of that paper, Maslow's Needs have changed and so the evaluation criteria must continually be improved. This implies that a smart city actually is a forever evolving "being" or as it is referred to by ETGI as "regenerative infrastructure," where an intelligent, AI-driven operating system continuously senses, models, and predicts community needs, and must be maintained as such.

This section summarizes how each category of Maslow's Hierarchy of Needs evolved between 1975 and 2025, with attention to the integration of technology, globalization, and contemporary psychology. One of the insights that we are looking for is the impact of the economy and economic conditions on the needs of the individuals and communities.
The evolution of Maslow's needs are:

1. Physiological Needs (food, water, shelter, sleep, etc.)
- 1975–1980s: Defined narrowly as biological survival needs (food, water, shelter, rest).
- 1990s–2000s: Expanded to include access to healthcare and clean environment.
- 2010s–2025: Digital access (internet, smartphones, electricity, connectivity) is now viewed as essential. The UN's 2016 declaration of internet access as a human right reflects this shift.

In other words, today's physiological needs are understood as 'basic access to life-enabling resources,' which now includes digital infrastructure alongside food, water, and shelter.

2. Safety Needs (security, stability, protection)
- 1970s–1980s: Focused on physical safety, job security, and law/order.
- 1990s–2000s: Workplace safety, economic stability, and healthcare access became key.
- 2010s–2025: Now includes cybersecurity, data privacy, digital identity protection, and climate security.

Safety today extends beyond the physical to include technological, informational, and environmental security.

3. Love & Belonging (relationships, intimacy, community)
- 1970s–1980s: Primarily family, friendship, and romantic ties.
- 1990s–2000s: Expanded to workplace belonging and community roles.
- 2010s–2025: Online/digital communities (social media, gaming, fandoms) are now vital sources of belonging. Globalization has expanded belonging beyond local communities.

Belonging now includes hybrid (physical + digital) networks essential to psychological well-being.

4. Esteem Needs (achievement, respect, recognition)
- 1970s–1980s: Recognition through local community, careers, and family roles.
- 1990s–2000s: Esteem tied to career achievement and consumerist status markers.
- 2010s–2025: Digital esteem (likes, followers, online reputation, personal branding) is central. Recognition is now both local and global via digital platforms.

Esteem is increasingly shaped by digital identity and online reputation.

5. Self-Actualization (personal growth, creativity, fulfillment)
- 1970s–1990s: Focused on realizing personal potential, creativity, and career excellence.
- 2000s–2010s: Broadened to include balance, wellness, and lifelong learning.
- 2015–2025: Expressed through innovation, entrepreneurship, activism, and digital creativity.

Figure 2. Digital Era Hierarchy of Needs.

Self-actualization today blends creativity, purpose-driven work, and digital self-expression.

In 2025 there also a level beyond self-actualization and that is self-transcendence as described in item 6.

6. Self-Transcendence (beyond the self)
- 2000s onward: Added as a stage above self-actualization.
- 2010s–2025: Encompasses spirituality, altruism, ecological stewardship, and global consciousness. Technology enables new channels for transcendence (e.g., online activism, global charity).

Self-transcendence is about contributing beyond the self to humanity, nature, or a higher purpose.

Summary of Evolution

The forgone conclusion is that digitization and technology are becoming part of the fundamental need of citizens (see Figure 2). However, technology and digitization are not enough to maximize the value of the citizen-centric smart cities. True urban

resilience arises from systemic coherence, integrating technological, ecological, and financial infrastructures under shared governance.

In other words, we are looking for a link to the financial markets/economies and how to design a "parallel" market based on asset-backed blockchain solutions (e.g. stablecoins). Specifically, whether there is a connection inside smart complexes, smart communities and smart cities?

Space Infrastructure

A dedicated satellite infrastructure will play a vital role in providing the evolving needs to the citizen and the community within smart cities. By providing reliable, high-speed communication links, satellites help bridge gaps where terrestrial networks may be limited and/or disrupted, ensuring uninterrupted access to digital services for residents and critical urban systems. Additionally, satellite networks support secure data transmission and real-time monitoring, which are essential for emergency response, traffic management, and public safety operations. The integration of satellite technology with existing urban infrastructure not only expands coverage but also fortifies resilience against cyber threats and natural disasters, making smart cities more adaptive and secure in an increasingly interconnected world.

To bridge the gap between these changing personal and societal needs and the workings of financial systems in smart cities, it is essential to examine how technology-driven innovations can support new economic models. As we move beyond self-actualization, toward self-transcendence, integrating financial and digital infrastructures becomes crucial in empowering citizens and promoting sustainable communities. This connection lays the groundwork for exploring the role of parallel digital markets and their effect on monetary stability within these innovative urban environments.

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Furthermore, satellite infrastructure will act as a backbone for seamless communication among Internet of Things (IoT) devices, facilitating robust Device-to-Device (D2D) and Machine-to-Machine (M2M) interactions in smart city environments. By providing reliable connectivity even in remote or densely populated areas, satellites will support the large data exchanges needed for automation, smart energy grids, intelligent transportation systems, and other vital urban applications. This capability is crucial for promoting the interconnectedness and operational efficiency that characterize next-generation smart communities.

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Parallel Markets and Monetary Stability

Parallel digital currency markets operate alongside fiat systems, offering *faster* settlement and compliance. They include regulator-led sandboxes, stablecoin venues, and cross-border central bank digital currency (CBDC) corridors.

The Quantitative Theory of Money (MV=PQ) shows how inflation depends on money supply and velocity. In 2008, despite QE-driven money supply growth, velocity fell, along-side a significant drop in consumer spending, preventing hyperinflation. This is contrary to what was known that increasing money supply should increase inflation. Similarly, parallel markets could stabilize fiat by absorbing demand.

Risks: run risk, de-pegging, illicit finance, regulatory conflicts, and adoption shortfalls. Governance and transparency are essential.

Inflation Targets and Measurement

Central banks target 2% inflation to preserve purchasing power, avoid deflation, and provide policy flexibility. However, inflation data lags by one to two months. Faster, digital-led measurement could reduce policy errors and support better monetary stability.

Inflation Measurement Has a Delay

Inflation is measured with price indices (CPI, PCE, etc.), which rely on large amounts of data about prices of goods and services. This data takes time to collect, process, and seasonally adjust. As a result, policymakers see inflation with as much as a two month lag. So how would reducing that lag time improve our ability to manage inflation?

If Inflation Were Measured Faster

Monetary Policy Timing

Central banks wouldn't have to rely as much on forecasts or "nowcasts" (model-based short-term estimates).

Faster, more accurate readings could reduce policy mistakes (e.g., tightening too late or easing too early).

This might reduce the "overshooting" or "undershooting" cycles we often see

Expectations Management

Inflation expectations (what businesses and households think inflation will be) are very influential.

Faster readings could stabilize expectations sooner, because the public would have clearer real-time signals rather than old data.

Target Itself

The level of the inflation target (2%, 3–4%, 0–1%) is based on long-run trade-offs, not just measurement lags.
So, a faster determination would not change the optimal number directly.
But it could make a higher or lower target more practical:
If central banks had near-real-time inflation data, they might feel more comfortable with a lower target (since they could react quickly to deflation risks).
Conversely, with slow data, a higher target provides more cushion against deflationary shocks.

Bottom Line

Faster determination of inflation would improve the timing and precision of monetary policy, potentially reducing the need for a cushion in the target. But the core arguments for whether the target should be higher or lower are mostly structural (about debt, wage stickiness, and credibility), so the actual number might not shift much — just the confidence in hitting it.

Parallel Markets

Beyond "Replacement" Narratives

A decade into crypto's rise, the most durable breakthroughs aren't headline tokens, they're the markets being built beside existing money. A parallel digital currency market doesn't seek to abolish existing legal tender, but instead, it carves out a lane where settlement is faster, compliance is embedded, and incentives line up for users and merchants.

The goal is not to disrupt central banks overnight but to design parallel venues—fully reserved stablecoins, tokenized deposits, or sandboxed CBDC corridors—where experimentation produces real economic value.

A "parallel" market is simply one that exists alongside the traditional fiat rails, with its own rules and liquidity, but with bridges back to banks and payment systems. It has three defining traits:

Co-existence, not replacement.
Specific use cases.
Regulatory clarity.

Reference Blueprints of Parallel Markets

Regulator-Led Walled Gardens

Sandbox environments let licensed firms issue and trade tokenized assets using parallel settlement currencies (e.g. EU DLT Pilot Regime, UK Digital Securities Sandbox).

Private Stablecoin Venues

Fully reserved stablecoins under frameworks such as MiCA (EU landmark law regulating crypto currencies - rules effective June 30, 2024 for stablecoins, Dec 30, 2024 for CASPs).

Cross-Border Wholesale Corridors

Multi-CBDC platforms (e.g., BIS Project mBridge, MVP in 2024).
Blueprint: Steps to Designing the Market

Risks and Mitigations

Run Risk

As with most financial markets, any run on the banking system forcing conversions into Fiat currency that requires significant reserves to support.

De-pegging

In addition, stablecoins are pegged to a fiat currency promising convertibility (i.e. liquidity). The peg builds trust by having sufficient reserves.

De-pegging is typically caused by (1). Reserve problems – If reserves are insufficient, illiquid, or risky (e.g., commercial paper instead of cash/treasuries), redemptions may fail, (2). Market panic – A wave of redemptions can push prices below $1 on exchanges, (3). Regulatory or operational shocks – Frozen bank accounts, lawsuits, or sanctions on issuers, and (4). Technical or smart contract flaws – In algorithmic stablecoins (like Terra/LUNA), design flaws can cause death spirals.

Illicit Finance

Is any movement of money that is illegal in origin, transfer, or use. Typically, money that comes from, supports, or conceals criminal activity. There are common types of illicit finance such as money laundering, terrorist financing, sanctions evasion, proliferation financing, corruption & bribery and tax evasion & illicit trade.

The result of illicit finance is that (1). It destabilizes economies by distorting markets or driving inflation, (2). weakens institutions - corruption and hidden flows that undermine trust, (3). Creates Global security risk – funds can fuel terrorism or organized crime.

Regulatory Conflict

There are a number of regulatory conflicts that will continue to be monitored.

Jurisdictional Conflicts

Cross-border rules don't align.

Example: An EU-compliant stablecoin (under MiCA) may not automatically satisfy U.S. SEC/CFTC expectations, or AML rules in Asia.

Result: A token that is legal in one country may be treated as a security, commodity, or even banned asset in another.

Licensing Overlaps

One authority may require an e-money license, while another calls the same instrument a security.

In the EU: a stablecoin can fall under MiCA (crypto rules) and also under PSD2 (payments/e-money rules) if it functions like an electronic money product.

Result: Issuers may need dual or triple licensing, creating compliance cost and uncertainty.

Conflicting Consumer Protections

Some regimes demand instant redemption rights for stablecoins (e.g., MiCA), while others allow delayed settlement.

Inconsistent disclosure requirements (whitepapers vs. prospectuses) may confuse users.

AML/CTF vs. Privacy Law

FATF's Travel Rule requires personal sender/receiver data to be shared between intermediaries.

EU GDPR privacy rules restrict how personal data can be processed and stored.
Result: Tension between compliance with AML and data protection rights.
Sandbox vs. Full Regime

Firms operating in a sandbox (like the EU DLT Pilot or UK DSS) may face conflict when moving to a permanent license — what was legal in the pilot may not be legal under the main law.

Sovereignty & Monetary Policy

A foreign-issued stablecoin gaining traction in a local market may conflict with central bank mandates.

Example: If a USD stablecoin dominates payments in Africa or Asia, local regulators may see it as currency substitution that undermines monetary sovereignty.

Tax & Accounting Mismatches

Different regimes classify crypto gains differently (capital gains vs. income).

Accounting standards (IFRS vs. US GAAP) may not agree on whether tokens are cash equivalents, intangibles, or financial instruments.

Adoption Shortfall

The biggest issue of any parallel market is adoption. With limited adoption, the parallel market will continue to erode until finally it disappears. The ability to gain efficiencies like controlling interest rates locally and temporally become impractical.

Lessons from Case Studies

- El Salvador (Bitcoin Legal Tender): limited daily use
- Nigeria (eNaira): <1% of cash in circulation as of 2024
- mBridge (CBDC Corridor): MVP shows wholesale viability

Policy Anchors

- MiCA Regulation: stablecoin rules June 30, 2024; CASP rules Dec 30, 2024
- FATF Travel Rule: June 2024 update
- Sandbox Routes: EU DLT Pilot, UK Digital Securities Sandbox
- Genius Act: US establishes a comprehensive regulatory framework for payment stablecoins ensuring they are backed by 100% reserves, subject to strict anti-money laundering (AML)

and sanctions compliance and have priority for holders in bankruptcy. Key features include the establishment of permitted issuers, monthly disclosure of reserve composition, and prohibition of misleading marketing regarding government backing or insurance.

The success of a parallel digital currency market depends on clear objectives, compliant design, transparent governance, and real-world incentives. Parallel markets create innovation zones where settlement is faster, inclusion is greater, and trust is earned through transparency.

In addition to stabilizing fiat, these markets catalyze regenerative value cycles—where citizens become participants in the data economy, converting informational assets into community capital.

Conclusion

For smart cities to achieve sustainable success, a citizen-centric approach is crucial, requiring the integration of social needs, strong governance frameworks, and solid economic bases. Historical examples like Songdo and Masdar show that technology-driven initiatives without meaningful public engagement and adaptive governance tend to underperform. In contrast, cities such as Curitiba, Singapore, and Seoul demonstrate the effectiveness of prioritizing citizen participation and responsive policy design.

The rise of parallel digital markets offers a strategic opportunity to improve systemic stability, complement traditional fiat systems, and boost urban resilience. These markets can form key parts of smart city ecosystems, as long as innovation is balanced with regulatory oversight and active community engagement. Ultimately, the success of smart cities depends on using technology as a helpful tool within a framework built on clear objectives, compliance, transparent governance, and real incentives for all stakeholders.

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