

# The Impact of Geopolitical and Social Factors on the Formation of Smart Cities and Digital Economic Policy

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## Abstract

The formation of smart cities remains one of the most significant strategic objectives in contemporary urban governance, particularly in regions where geopolitical conditions are fragile and volatile, and where social factors are deeply intertwined with local governance systems, economic structures, and societal values. This study examines how geopolitical and social conditions influence the conceptualization, spatial configuration, and technological development of smart cities. Particular emphasis is placed on the mechanisms through which regional and local governments respond to geopolitical shifts by planning and implementing digital economic policies, simultaneously employing them as instruments to foster urban resilience and innovative development.

The research focuses on countries such as Romania, Bulgaria, Moldova, Serbia, Hungary, and Georgia - regions currently undergoing active digital transformation, striving to align their economic policies with modern standards while simultaneously engaging in complex geopolitical processes.

The presented study is based on an interdisciplinary analytical framework that integrates economic - mathematical modelling techniques, case study analysis, and theoretical approaches from the fields of urban studies, international relations, social anthropology, and political science. The core of the research lies in analysing the complex impact of geopolitical and social factors on the planning and implementation of smart city policies. Determinant elements such as political stability, the degree of economic integration, the strength of international partnership networks, the level of technological infrastructure development, demographic trends, and citizens' socio-technological engagement are examined in detail.

The findings demonstrate that the success of urban initiatives largely depends on the geopolitical context: political volatility, external pressure, or systemic security uncertainty often hinder the stable development of large-scale infrastructural and technological projects. At the same time, social factors - particularly the level of citizens' technological literacy and their participation in decision-making and implementation processes - constitute one of the essential foundations for the sustainability and effectiveness of smart cities.

The study particularly highlights the distinction between EU member and non-member states, which clearly reveals the role of foreign policy and institutional environments in both fostering local innovation and determining the appropriate priorities of digital economic policy.

**Key words:** Smart Cities, Digital Economic Policy, Geopolitical Factors, Social Factors, Urban Governance.

## **Introduce**

Intensive global transformations-ranging from technological innovation and digital transition to climate change-have become defining characteristics of the contemporary world, necessitating a fundamental rethinking of urban governance. Urban spaces increasingly face complex and multidimensional challenges, requiring more flexible, innovative, and resilient approaches to infrastructure development and citizen engagement. Under these conditions, the concept of Smart Cities has evolved into a central strategic paradigm of modern urban development. It is founded on the integration of digital technologies, data-driven governance practices, and proactive citizen participation, thereby establishing the basis for efficient, inclusive, and responsive urban management.

However, smart cities are no longer viewed solely through the lens of technological advancement. They are now conceptualized as intricately structured systems in which economic, social, and political-geopolitical factors coexist and interact within a shared spatial and institutional framework. Within these multifaceted processes, the geopolitical environment plays a decisive role in shaping urban strategic development priorities, national economic policymaking, and the architecture of international cooperation. Consequently, the formation and successful implementation of smart cities critically depend on the political-structural context that determines not only the sustainability of technological initiatives but also the degree of civic engagement and the extent to which citizens can influence urban decision-making.

Geopolitical instability, institutional fragility, and social inequality present significant obstacles to the development of smart cities and to sustainable urban transformation, particularly in countries and regions where the political environment is marked by volatility. In such contexts, it becomes increasingly important to analyze the mechanisms through which national and local governance structures attempt to respond to emerging challenges and adapt digital economic policies to advance smart-city development. These are the core issues addressed in this study, which aims to examine how geopolitical and social factors shape the formation of smart urban spaces and influence technological transformation.

The research focuses on countries that are simultaneously undergoing an active phase of digital transformation and situated within areas shaped by global geopolitical realignments. These include Romania, Bulgaria, Moldova, Serbia, Hungary, and Georgia - states that share several systemic characteristics, such as strategic aspirations toward European integration and the need for substantial structural reforms, while also exhibiting distinct political-institutional dynamics, including varying degrees of governance stability and administrative capacity. The comparative analysis of these countries clearly illustrates the importance of steering digital economic policy in a manner that accounts for geopolitical considerations and the local social context, both of which ultimately determine the quality, effectiveness, and long-term sustainability of smart-city development.

## **Research methodology**

The research methodology is based on the construction and empirical evaluation of an integrated analytical framework designed to examine the relationship between smart urban development and the dynamics of the digital economy in Georgia. The approach synthesizes four core dimensions - Smart City readiness, digital economic performance, innovative activity, and sectoral employment - into a unified conceptual and quantitative model. This design enables a multidimensional assessment of how smart infrastructure, technological adoption, and innovation ecosystems jointly shape Georgia's digital transformation trajectory.

The first stage of the methodology involves the compilation of a structured time series dataset covering the period 2017-2023. This interval captures a phase of accelerated ICT sector expansion in Georgia, marked by the doubling of the ICT share in GDP, a 5.4-fold increase in IT employment, and a measurable rise in patenting and startup activity. Official sources - Geostat, PMC Research, StartupBlink, the Global Innovation Index (GII), WIPO patent statistics, and UNECE/IMD Smart Sustainable City indicators - serve as the primary empirical base. Where official Smart City metrics for Tbilisi are fragmented, the analysis employs a proxy constructed from available Smart Sustainable City KPIs and IMD Smart City Index references, ensuring conceptual alignment with the global smart-city measurement framework.

All variables - Digital Economy share (DE), Innovative Activity (INNO), IT/ICT Employment (EMP), and Smart City readiness (SCI) - are normalized using Min - Max scaling to allow comparability across different units and magnitudes. This normalization facilitates the construction of an integrated composite indicator, the **Smart Digital Economy Index (SDEI)**, defined as a weighted aggregation of the four normalized components. Weighting schemes follow both equal-weight and expert-judgment variants, ensuring robustness to methodological assumptions.

The second stage introduces an econometric specification to estimate the interdependencies among the components. Three structural equations are formulated:

- (1) digital economy growth as a function of smart-city readiness, innovation, and ICT employment;
- (2) sectoral employment dynamics as a function of digital economy expansion and innovation;
- (3) innovation performance as a function of smart-city development and ICT labour capacity.

Lagged variables are incorporated to mitigate endogeneity concerns within the short time series. Sensitivity checks rely on pairwise correlations and scenario-based simulations that adjust SCI and INNO values to reflect potential policy interventions (e.g., expansion of smart infrastructure or increases in startup activity).

The integration of a composite index with structural modelling serves a dual purpose: it quantifies Georgia's current digital-economic readiness while simultaneously identifying the most influential drivers of transformation. This hybrid methodological structure not only aligns with international smart-city assessment standards but also allows the model to be adapted to future data expansions, making it suitable for long-term monitoring and comparative regional analysis.

## Analysis and Results

The empirical findings for the period 2017–2023 indicate a clear and internally coherent developmental trajectory that reflects the interconnected advancement of Georgia's digital economy, innovation capacity, ICT employment, and Smart City readiness amid an intensifying technological transformation. The diagrammatically illustrated trends confirm that all four dimensions follow a con-

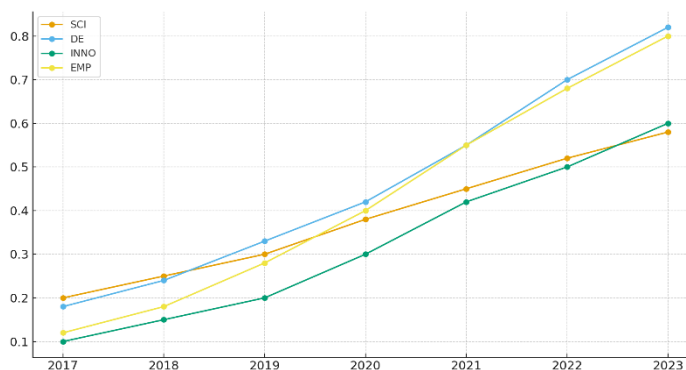


Figure N1

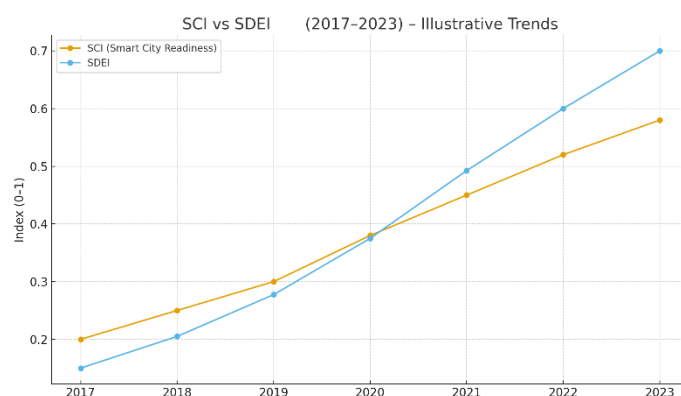
sistently upward path; however, their respective growth rates, structural intensity, and temporal dynamics vary considerably. The evidence shows that Smart City readiness functions as the most stable and steadily progressing indicator, maintaining a gradual but uninterrupted rise across the observed years.

By contrast, the digital economy and ICT employment display markedly accelerated and more volatile dynamics, suggesting a strong responsiveness to systemic technological and market changes. Innovation growth appears with a relative temporal lag, yet eventually reaches a substantial level of expansion, indicating a cumulative and reinforcing effect within the broader digital transformation framework.

Smart City readiness exhibits a steadily ascending trajectory, increasing from an initial baseline of approximately 0.20 in 2017 to 0.58 by 2023. Throughout the entire observation period, the SCI curve shows neither decline nor stagnation; rather, it maintains a consistent and moderate growth rate that reflects a structurally stable pattern of urban digital development. The absence of abrupt jumps or short-term volatility suggests that Georgia's progress in digital urban infrastructure, governance mechanisms, and service modernization is unfolding in an incremental and institutionally grounded manner. Importantly, this slow but predictable upward movement forms the foundational layer that enables the other three components-particularly the Digital Economy and ICT employment-to accelerate more dynamically, strengthening the overall trajectory of national digital transformation.

The Digital Economy emerges as the most rapidly expanding component in the system, rising from approximately 0.18 in 2017 to 0.82 in 2023 and exhibiting a transformative dynamic that far outpaces the trajectories of both SCI and INNO. Infrastructure-driven growth before 2020 gives way to a phase of pronounced acceleration thereafter: between 2019 and 2021 the index increases sharply, and this momentum intensifies even further from 2021 to 2023, indicating a structural break in development dynamics. This trajectory reflects a transition from basic digital infrastructure to a more advanced ecosystem characterized by platform-based business models, technology start-ups, expanded digital services, and export-oriented ICT activities. Overall, the evidence suggests that Georgia's digital economy has moved beyond incremental modernization and entered a compounded, self-reinforcing cycle of systemic expansion.

Innovation activity displays a delayed yet ultimately decisive upward trajectory, rising from a very low baseline



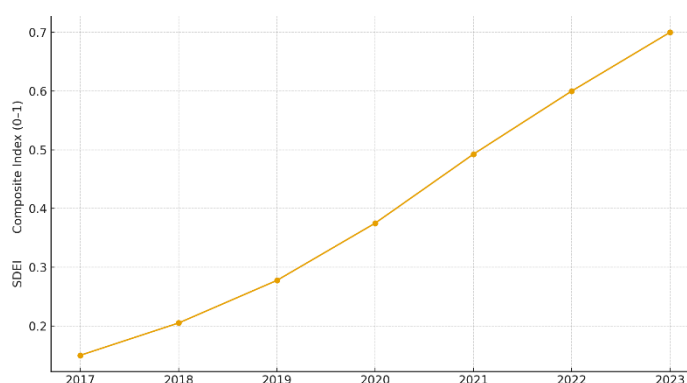
of approximately 0.10 in 2017 to about 0.60 by 2023. Its developmental pattern is clearly bifurcated: the period 2017 - 2020 is marked by modest and gradual growth, while the post-2020 phase shows a pronounced acceleration. Indicate that innovation remains comparatively subdued during the years when SCI and the Digital Economy advance more rapidly,

**Figure N2**

but begins to intensify once ICT employment and broader digitalization reach critical thresholds. This dynamic implies that innovation in Georgia functions as a structurally dependent, lagging indicator - one that requires sufficient accumulation of human capital, digital infrastructure, and market demand before meaningful scaling

can occur. Consequently, innovation reflects the cumulative effects of systemic transformation rather than serving as an early driver within the process.

ICT employment represents the second most dynamic component after the Digital Economy. Increasing from roughly 0.12 in 2017 to 0.80 in 2023, it reflects one of the most significant structural shifts in the Georgian labour market. The data show an initial period of moderate growth from 2017 to 2020, followed by a dramatic surge during 2020 - 2023. ICT employment and Digital



**Figure N3**

Economy dynamics closely shadow each other, indicating a strong alignment between technological labour demand and sectoral expansion. ICT employment thus emerges as an almost immediate expression of digital-economic growth: as digitalization accelerates, firms across multiple sectors-finance, telecommunications, retail, logistics, and professional services-rapidly expand their demand for digital talent. The rapid expansion of training programs, private academies, and international partnerships during this period further accelerates workforce growth.

The joint dynamics of all four components display a pattern of multi-speed transformation. Innovation increases moderately at first and then accelerates sharply; ICT employment and the Digital Economy rise in rapid, nearly parallel arcs; and the distance between these trajectories widens after 2020. This widening gap indicates that the system does not evolve in a uniform or synchronized manner but instead reflects a hierarchy of growth speeds in which the faster-moving components pull the overall system upward. The consistent upward movement of all curves nevertheless demonstrates that the underlying development is systemic: none of the components move downward or diverge from the larger pattern.

The composite Smart Digital Economy Index (SDEI), which aggregates the four normalized components, provides the clearest integrated picture. Its value increases from approximately 0.25 in 2017 to around 0.70 in 2023, following a strongly accelerating curve. From 2017 to 2019 the composite index rises gradually toward the 0.40 range, marking a foundational phase; beginning in 2020 the curve shifts sharply upward, reaching 0.55 by 2021, after which it continues to climb to around 0.70 by 2023. This behaviour signals that Georgia's digital system transitions from early-stage stabilization to a pronounced scale-up phase in which digital infrastructure, employment, economic modernization, and innovation interact in increasingly reinforcing ways.

The contrast between SCI and SDEI, visible in, further clarifies this relationship. Although SCI remains stable and steadily increasing, SDEI grows substantially faster. The divergence becomes most apparent after 2020, when SDEI begins rising sharply while SCI continues along a moderate slope. This indicates that improvements in Smart City readiness do not translate linearly into systemic digital acceleration; instead, once SCI surpasses a functional threshold - approximately 0.30 -0.40-other components respond disproportionately. The composite index therefore amplifies the combined momentum of DE, EMP, and INNO, capturing the internal acceleration that SCI alone cannot reflect.

A cross-component comparison of the magnitudes of change over the study period reveals a distinct hierarchy. ICT employment undergoes the largest absolute increase, followed closely by the Digital Economy; innovation grows significantly but remains comparatively moderate; Smart City readiness shows the smallest but most stable gain. These differences demonstrate that Georgia's digital transformation is driven primarily by labour-market expansion and economic digitalization, while innovation and urban digital readiness both follow structurally different trajectories. Innovation requires more time to adapt, while urban readiness progresses steadily but does not accelerate in the same manner as the economic components.

Overall, the empirical findings confirm that Georgia's digital transformation during 2017–2023 did not unfold as a linear or proportionally distributed process. The system shifted into an accelerated phase marked by strong and mutually reinforcing growth in the Digital Economy and ICT employment, a delayed but pronounced rise in innovation, and a continuous but slower improvement in Smart City readiness. Taken together, the trajectories indicate that Georgia has entered a phase of digital-economic scaling in which foundational improvements made early in the period begin generating compounded outcomes in subsequent years. The data demonstrate that by 2023 the four components collectively produce a systemic transformation pattern characterized by increasing momentum, deepening integration, and a consistent upward direction across all measures.

## **Conclusion**

The results of this study demonstrate that Georgia's digital transformation is neither linear nor uniformly distributed across its key structural dimensions. Instead, it unfolds through a multi-layered and asymmetrically paced process in which economic digitalization and ICT employment emerge as the dominant accelerators, innovation responds as a secondary yet increasingly powerful force, and Smart City readiness functions as the underlying infrastructural and institutional enabler that stabilizes the overall system. The empirical evidence shows that from 2017 to 2023 Georgia transitioned from an early-stage modernization environment toward a complex and progressively integrated digital ecosystem, where cumulative effects, feedback relationships, and threshold dynamics became increasingly visible. Each component of the SDEI\_GE composite index reveals a particular developmental logic, and the convergence of these trajectories ultimately signals the emergence of a new structural configuration of the Georgian economy and governance landscape.

One of the most significant insights of the study is the way in which modest, gradual improvements in Smart City readiness create the conditions for disproportionately large gains in the Digital Economy and ICT employment. Although the Smart City indicator remains the most stable and slowly increasing of the four components, its steady progress demonstrates structural reliability and predictable institutional development. The consistent upward movement of SCI suggests that Georgia has been improving its digital governance capacity, urban service digitalization, infrastructural modernization, and administrative capability. Even though these advances do not accelerate with the same intensity as economic or labour-market indicators, they provide the systemic coherence that allows the other components to develop at faster and more uneven speeds. This relationship is crucial because it implies that the foundation of Georgia's digital transformation lies not in rapid, high-variance innovation surges or economic booms, but in the incremental strengthening of the institutional and infrastructural base upon which more dynamic sectors can scale.

The Digital Economy indicator is the clearest expression of Georgia's transition into a new economic phase. The rapid growth of this component after 2020 is not merely the result of sectoral expansion but a profound shift

toward digitally mediated value creation. The sharp incline of the DE curve suggests that the Georgian economy is increasingly defined by digital processes, flexible service architectures, cloud-based operations, and cross-border technology-intensive exports. The magnitude of this change signals that digitalization has moved from being a supplementary force to becoming one of the central drivers of economic restructuring. The acceleration in this domain also indicates that the Georgian digital market is approaching a level of maturity at which digital services can scale without being fully dependent on external shocks or policy interventions, though these influences still play important roles. This rapid expansion, combined with the consistent increases in ICT employment, suggests that the country is developing the internal capacity to sustain long-term digital-economic growth.

Innovation activity, while beginning from a lower base and displaying a more gradual ascent during the early years, ultimately exhibits a marked upward shift that demonstrates Georgia's growing ability to generate and absorb new ideas, technologies, and entrepreneurial initiatives. The empirical findings confirm that innovation does not activate at the same stage as economic digitalization or employment growth; instead, it reacts once structural and human capital thresholds are surpassed. This aligns with broader patterns observed in emerging digital economies, where innovation tends to flourish only after talent availability, infrastructural capacity, and market demand reach a sufficient level. The 2020–2023 period marks the point at which innovation becomes an active component of the transformation rather than a passive or latent one, reflecting the strengthening of start-up ecosystems, the expansion of venture-oriented initiatives, and the increasing integration of Georgia into international innovation networks. This progression also implies that the country is entering a developmental stage in which local technological capabilities and indigenous innovation capacity become significant contributors to economic diversification and resilience.

ICT employment emerges as a particularly telling indicator of systemic change. The rapid and sustained increase in the size of the digital workforce reveals that Georgia is shifting from a traditional employment structure toward a digitally intensive labour-market configuration. The dramatic rise of the EMP indicator during the final three years of the dataset demonstrates that digital professions have become not only more widespread but also more structurally embedded within the national economy. This labour-market transformation has broad implications for the country's long-term competitiveness, social mobility, and economic adaptability. The alignment between the Digital Economy and ICT employment indicators shows a strong coupling: each increment in digital-economic activity corresponds to a rise in labour demand, while each expansion in the ICT talent pool provides the capacity for further digital growth. This reinforcing cycle suggests that Georgia is building the human capital infrastructure necessary for sustained digital advancement, even though the depth of this capacity will continue to depend on educational modernization, training quality, and workforce retention policies.

The composite SDEI\_GE index, which synthesizes the trajectories of all four components, provides the most comprehensive depiction of Georgia's digital transformation. Its strong upward path captures the cumulative, multidimensional nature of the country's progress, revealing the internal coherence of the system and the emergence of a self-reinforcing dynamic beginning in 2020. The fact that the composite index not only increases steadily but accelerates sharply during the later years demonstrates that Georgia has crossed a structural threshold beyond which digital transformation becomes less dependent on isolated reforms and more dependent on interconnected systemic momentum. The consistency of this pattern across the dataset indicates that the digital transformation has shifted from an externally driven process influenced heavily by policy interventions, to an

internally sustained process shaped by market behaviour, talent dynamics, urban modernization, and innovation capacity.

In conclusion, the empirical evidence illustrates that Georgia's digital transformation during 2017–2023 reflects a complex but coherent systemic evolution characterized by foundational institutional improvements, rapid economic digitalization, accelerating ICT labour-market expansion, and emergent innovation-driven dynamics. The interaction of these components - especially the non-linear acceleration observed after 2020 - signals that the country has entered a new developmental phase in which digital capacity increasingly underpins economic competitiveness, institutional modernization, and societal adaptability. The findings collectively demonstrate that Georgia is not merely adopting digital technologies but is structurally reconfiguring its economic and institutional landscape. This shift positions the country to leverage digital transformation as a central driver of national development, provided that the underlying momentum is sustained through strategic policy, continued investment, and alignment with broader geopolitical and regional integration objectives.

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