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Digital Infrastructure and Territorial Intelligence: The Role of ICT Accessibility in Smart City Development

A territorial engineering approach to connectivity and digital transformation

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ABSTRACT

Digital infrastructure is a foundation of smart-city development, but network coverage alone does not guarantee that residents can access, understand or benefit from digital services. This article examines information and communication technology (ICT) accessibility as a territorial planning issue and develops a territorial engineering framework for inclusive digital transformation in Rabat. It draws on the descriptive findings of a thesis questionnaire study (N = 349; 348 valid responses per item) and proposes an operational cycle linking spatial diagnosis, co-designed priorities, shared digital infrastructure, and evaluation. In the five-item ICT-access dimension, 35.1% of respondents agreed overall, 30.2% disagreed and 33.6% were neutral. Perceptions varied by item: 42.8% agreed that connectivity infrastructure was well deployed, but 41.1% disagreed that online services were accessible to all citizens and 46.5% disagreed that disadvantaged populations benefited from digital-inclusion programmes. The access scale showed acceptable internal consistency in the thesis (Cronbach's $\alpha = .836$; KMO = .847; Bartlett's $\chi^2 = 617.032$, df = 10, $p < .001$). These diagnostics support use of the survey scale for descriptive analysis, not causal or predictive conclusions. The proposed approach reframes territorial engineering as the coordination of spatial evidence, infrastructure investment, service design, digital capability and institutional responsibility. It emphasizes place-based indicators, interoperability, assisted and offline service routes, , citizen participation and continuous monitoring.

The article does not claim to have evaluated a digital platform or a new ICT intervention; it provides a thesis-grounded framework and measurement agenda for subsequent territorial planning and implementation.

Keywords: ICT accessibility; digital infrastructure; territorial intelligence; territorial engineering; smart city; digital inclusion; Rabat; Morocco

1. INTRODUCTION

Smart-city strategies increasingly rely on digital networks, data platforms and online public services. Their value depends on whether people can connect, use services confidently and obtain meaningful benefits from them. Digital inequality can persist even where broadband is widely available because affordability, devices, skills, accessible design, language and institutional support shape the conversion of connectivity into participation and opportunity (Lythreatis et al., 2022; Caragliu & Del Bo, 2023; Colding et al., 2024). The challenge is therefore territorial as well as technological: different neighbourhoods and population groups may face different barriers, and public investment must be coordinated across infrastructure, services and local capabilities.

Territorial intelligence refers here to the capacity of public institutions, residents and local organizations to understand territorial conditions, share knowledge and coordinate decisions. Territorial engineering is the practical process that turns this intelligence into action: diagnosing needs spatially, mobilizing institutions and resources, designing interventions, implementing them, and assessing their effects. This article brings the two ideas together to frame ICT accessibility as a planning outcome rather than a narrow connectivity target. The approach is relevant to smart-city programmes in which digital services are intended to support education, health, administration, economic activity and civic participation (Sha et al., 2024; OECD, 2024a).

The empirical basis is a questionnaire study reported in a thesis on territorial intelligence and development in Rabat. The thesis findings show a mixed pattern: respondents were more likely to agree that connectivity infrastructure was deployed than to agree that online services were accessible to everyone or that disadvantaged groups received support to reduce the digital divide. The purpose of this article is to interpret these findings, specify a territorial engineering framework, and propose indicators for future implementation. The analysis does not establish causal effects, map actual network coverage, or evaluate a digital transformation programme.

The article addresses three questions: (1) what ICT-access priorities emerge from the thesis survey; (2) how can territorial engineering connect these priorities to place-based planning and implementation; and (3) what indicators and governance arrangements can make digital transformation more inclusive and accountable?

2. CONCEPTUAL FRAMEWORK

2.1 ICT accessibility as a layered territorial condition

ICT accessibility is treated as a sequence of related but distinct conditions. The first is physical availability: broadband, mobile coverage, public Wi-Fi, electricity and reliable devices. The second is effective affordability and usability, including subscription cost, device access, accessibility features and language. The third is capability: digital skills, confidence, support and the ability to navigate services. The fourth is conversion into outcomes, such as completing an administrative procedure, accessing information, learning, finding work or participating in local decisions. Digital-divide research distinguishes access from differences in skills, uses and outcomes, warning against treating network reach as a complete measure of inclusion (Lythreatis et al., 2022; Caragliu & Del Bo, 2023).

A city may therefore score well on infrastructure while retaining gaps in service access and digital capability. Smart-city design can reduce or reproduce these gaps depending on whether it accounts for income, age, disability, gender, education, language and location (Colding et al., 2024; Sha et al., 2024). An inclusive plan should maintain assisted, in-person or offline routes for essential services so that digitalization expands options instead of making connectivity a condition for exercising basic rights.

2.2 Territorial intelligence and territorial engineering

Territorial intelligence provides the shared evidence and deliberation needed to identify where barriers occur and which institutions can address them. Territorial engineering supplies implementation methods. In this article, it comprises five connected functions: spatial diagnosis; coordination among public bodies and service providers; co-design with residents; alignment of investment, skills and service operations; and monitoring with a feedback process. The approach extends infrastructure planning by linking technical network assets to public-service access and territorial cohesion.

A place-based approach also guards against citywide averages that hide uneven conditions. Urban–rural and within-city digital gaps are shaped by network investment, geography, institutional capacity and socioeconomic conditions (Pelucha

et al., 2023; Dragan et al., 2023). Mapping access at a suitable neighbourhood scale, with privacy-protective aggregation, can help authorities identify service deserts, prioritize public access points and coordinate upgrades with other spatial plans.

2.3 Digital public infrastructure and public value

Digital public infrastructure (DPI) includes reusable systems and shared components that support identity, payments, data exchange, communication and service delivery. OECD guidance emphasizes interoperability, security, inclusion, resilience and user experience as important features of DPI (OECD, 2024b). In a territorial setting, common standards can reduce fragmentation among local services and enable a resident to complete a task across institutions. However, interoperability should not imply indiscriminate data pooling. Purpose limitation, data minimization, access control and clear accountability are essential to maintain public trust (OECD, 2024c; UNESCO, 2021).

ICT-enabled governance can also expand participation when digital channels are accessible and linked to real decision processes. Yet online consultation alone does not constitute meaningful participation if participants cannot influence priorities or receive feedback. Planning research on AI-enabled and digital participation calls attention to communication, representation, and the connection between digital inputs and formal planning decisions (Du et al., 2024; Das, 2024).

3. DATA AND METHODS

3.1 Study basis and scope

This article uses descriptive frequency tables from the thesis questionnaire. The thesis reports an overall sample of 349 respondents. Each ICT-access item presented below has 348 valid responses and one system-missing response. No respondent-level dataset was available for reanalysis in this manuscript; therefore, all percentages are transcribed from the thesis tables, and no new inferential tests or subgroup comparisons are claimed. The source tables identify perceptions of residents about internet access, connectivity deployment, online services, digital-inclusion programmes and access to new technologies.

3.2 Measurement diagnostics

For the five-item "increase in ICT access" scale, the thesis reports KMO = .847 and Bartlett's test $\chi^2 = 617.032$ (df = 10, $p < .001$), together with Cronbach's alpha $\alpha = .836$. These statistics indicate that the item set showed acceptable internal consistency and that its correlations were suitable for exploratory factor analysis in the thesis. They do not validate an external digital-inclusion index or establish causality. The broader thesis confirmatory model reports RMSEA = .251; in view of this poor fit statistic, structural paths from that model are not used here as confirmatory evidence.

3.3 Analytical strategy

The article first aggregates the two disagreement categories and two agreement categories for each item, retaining neutrality and "do not know" responses as separate categories. It then interprets item-level differences through the proposed territorial engineering framework. The framework is a conceptual research and planning design; it is not a tested platform, causal model or policy evaluation.

4. RESULTS

4.1 Perceptions of ICT access

The five-item mean provides a balanced overall picture: 30.2% of valid responses were in disagreement, 33.6% were neutral, 35.1% were in agreement and 1.1% were "do not know." The near balance between disagreement and agreement, alongside the large neutral group, suggests heterogeneous experiences rather than a uniform assessment of access.

At item level, 42.8% agreed that Wi-Fi, broadband and related connectivity infrastructure were well deployed, compared with 30.7% who disagreed. For easy and affordable internet access, agreement was 38.0% and disagreement 35.3%. Perceptions were less favorable regarding inclusion in service outcomes: 41.1% disagreed that online services such as e-administration and e-health were accessible to all citizens, while 30.5% agreed. The sharpest concern concerned programmes to reduce the digital divide: 46.5% disagreed that disadvantaged populations benefited from such programmes, compared with 25.5% in agreement; 10.3% did not know. For access to new technologies for all inhabitants, 39.9% disagreed and 31.1% agreed.

Table 1: Valid response percentages for five ICT-access items from the thesis survey (Tables 91–95). Disagreement and agreement combine the two respective response categories. Percentages may not total 100 because of rounding.

ICT-access statement	Disagree (%)	Neutral (%)	Agree (%)	Do not know (%)	Valid n
Internet access is easy and affordable	35.3	22.1	38.0	4.6	348
Connectivity infrastructure is well deployed	30.7	22.1	42.8	4.3	348
Online public services are accessible to all	41.1	22.7	30.5	5.7	348
Disadvantaged groups benefit from digital-divide programmes	46.5	17.5	25.5	10.3	348
New technologies are accessible to all inhabitants	39.9	20.4	31.1	8.6	348

4.2 A gap between network rollout and inclusive use

The contrast between connectivity deployment and online-service accessibility is a central finding. Perceived deployment of infrastructure drew more agreement than the claim that online services were accessible to all. A larger negative response was reported for digital-inclusion programmes. This pattern points to a planning and delivery gap: investments in networks and platforms may not automatically resolve affordability, skills, usability, outreach or support barriers. Because the survey measures perceptions, it cannot determine which specific barrier explains the gap; those mechanisms require further local measurement.

5. TERRITORIAL ENGINEERING FRAMEWORK FOR INCLUSIVE DIGITAL TRANSFORMATION

The proposed framework translates the survey priorities into an implementation cycle. It treats territorial engineering as the coordinated practice of diagnosing, planning, financing, implementing and evaluating digital accessibility at an appropriate spatial scale. Four stages are proposed.

5.1 Stage 1: territorial diagnosis

The diagnosis should combine network availability and quality with affordability, devices, service access, skills and user experience. Indicators should be mapped by neighbourhood or service area and, where ethically and statistically appropriate, disaggregated by age, disability, gender, income or other relevant dimensions. Administrative data should be complemented by community surveys, assisted-user interviews and accessibility audits. A clear metadata record should describe source, date, spatial resolution, coverage and known bias for every indicator. The resulting diagnosis can identify locations where physical connectivity exists, but residents struggle to use essential services.

5.2 Stage 2: co-design and territorial coordination

Local authorities should convene digital-service departments, infrastructure operators, schools, health providers, civil society, community organizations and residents. The aim is to translate the diagnosis into a small set of place-specific priorities: for example, extending affordable access points, improving service usability in Arabic and French, adding disability-accessible interfaces, or offering assisted digital support at existing public facilities. Consultation should include in-person and non-digital channels and should explain how feedback affects the plan.

5.3 Stage 3: shared digital foundations and capacity

The engineering plan should align connectivity investment with shared and interoperable service components, secure data exchange and local skills development. Common standards can reduce duplication, while open interfaces and data portability can limit dependency on a single provider. Public institutions need technical, procurement and governance capacity to manage contracts, service quality and cybersecurity. Community-facing capacity is equally important: training, help desks and trusted intermediaries can support people who are new to digital services. Digital infrastructure should include resilience planning for outages and maintain alternative access routes to critical services.

5.4 Stage 4: implementation, evaluation and adaptation

Evaluation should distinguish inputs, outputs and outcomes. Network kilometres, public access points and service uptime measure infrastructure delivery; successful completion rates, user-reported difficulty, waiting time and abandonment measure service use; and differences in these outcomes between neighbourhoods can reveal distributional effects. Monitoring should also track privacy incidents, accessibility defects and service interruptions. Territorial plans should be revised when evidence shows that an intervention has not improved meaningful access or has shifted burdens onto groups with fewer alternatives.

Figure 1 presents the proposed territorial engineering cycle. The diagram is a conceptual model developed for this article; it does not depict a deployed Rabat system.

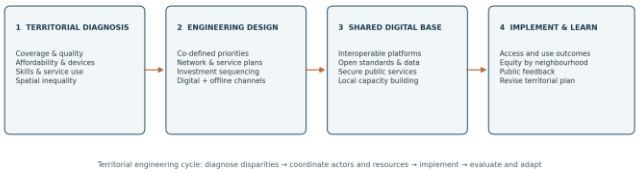

Figure 1: Proposed territorial engineering cycle for inclusive ICT access and smart-city development.

6. DISCUSSION

6.1 Reframing smart-city progress

The thesis results suggest that ICT planning should move beyond a binary distinction between connected and unconnected places. A stronger evaluation asks whether connectivity is affordable, whether services work for residents with different needs, whether people can get assistance, and whether digital channels lead to usable outcomes. This interpretation is consistent with research connecting smart-city policies to urban digital divides and social sustainability (Caragliu & Del Bo, 2023; Colding et al., 2024). It also supports treating service accessibility as a core territorial performance measure rather than a late-stage inclusion measure.

The large neutral share on the overall access scale matters for territorial engineering. Neutrality may reflect uncertainty, limited experience with services, uneven infrastructure or different interpretations of the questions. The data do not identify which explanation applies. Follow-up assessment should therefore ask about concrete tasks and local conditions instead of assuming that neutral responses mean satisfaction or indifference.

6.2 Territorial engineering as institutional coordination

The framework positions territorial engineering between strategic planning and frontline service delivery. It helps connect spatial evidence to budgets, service standards, infrastructure contracts and local participation. A municipal digital strategy should identify which actor owns each action, how national and local programmes align, and how maintenance and operating costs will be funded. A map of weak coverage without an accountable implementation pathway is a diagnosis without engineering. Conversely, a platform deployment without a territorial diagnosis risks improving services only for residents who are already well connected.

The framework also has implications for spatial planning. Digital infrastructure, public access facilities and digital-support services can be coordinated with libraries, schools, health centres, transport hubs and community facilities. This can create accessible points of support without requiring every public service to be delivered exclusively online. Digital investments should be integrated into wider plans for public facilities and neighbourhood development, with local monitoring used to revise priorities as population needs change.

6.3 Governance and safeguards

Inclusive digital transformation requires clear public responsibility for service standards, data protection and redress. Shared digital infrastructure can improve interoperability and reduce fragmented user journeys, but data governance rules must state what information is collected, for what purpose, who can access it and how long it is retained (OECD, 2024b; UNESCO, 2021). Procurement should require accessible design, security testing and continuity plans. Residents should be able to report service problems and obtain human assistance. Digital services should supplement, not eliminate, non-digital routes for essential functions.

Participation needs an institutional response: authorities should publish priorities, explain the criteria used to select interventions and report progress in accessible formats. Digital participation tools can broaden reach, but they must not become the only channel for consultation. An inclusive process treats community knowledge as evidence and gives participants a visible path from contribution to decision (Du et al., 2024; Das, 2024).

6.4 Limitations and future work

This article is limited to descriptive perceptions reproduced from thesis tables. It does not measure objective broadband quality, service completion, digital skills or geographical inequality, and it cannot identify causal effects. The questionnaire sample and fieldwork procedures should be fully documented in the thesis records before journal submission. No new primary data were collected and no digital platform or intervention was tested. The thesis' broader confirmatory model reports RMSEA = .251, so its structural paths are not treated as validation. Future work should link respondent-level or representative survey data to appropriately aggregated neighbourhood indicators, conduct

accessibility audits, and evaluate specific service or infrastructure interventions over time.

7. RESEARCH PROPOSITIONS

P1. Neighbourhood-level planning that combines coverage, affordability, skills and service-usability indicators will identify ICT-access gaps that are not visible in citywide connectivity averages.

P2. Coordinating connectivity investment with assisted access, digital-skills support and accessible service design will be associated with higher rates of successful public-service use than infrastructure deployment alone.

P3. Co-designed territorial engineering plans with named institutional responsibilities and funded implementation measures will show stronger follow-through than plans based only on platform procurement.

P4. Maintaining offline and assisted channels alongside digital public services will reduce exclusion risks for residents facing connectivity, capability or accessibility barriers.

CONCLUSION

ICT accessibility is a territorial development issue because the benefits of digital transformation depend on where infrastructure is available, who can afford and use it, and whether services respond to residents' needs. In the Rabat thesis survey, perceived connectivity deployment was more favorable than perceived access to online services for all and the reach of programmes for disadvantaged populations. The results call for a planning approach that connects network investments with service accessibility, local capabilities and public accountability. The proposed territorial engineering cycle provides a way to organize this work through spatial diagnosis, co-design, shared digital foundations and outcome monitoring. It remains a framework for future implementation and empirical evaluation, not evidence that an intervention has already produced these effects.

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